

FINAL
HAZARD RANKING SYSTEM PACKAGE
FOR
NUCLEAR METALS, INC.
CONCORD, MASSACHUSETTS

CERCLIS NO. MAD062166335

HAZARD RANKING SYSTEM (HRS) PACKAGE
RESPONSE ACTION CONTRACT (RAC), REGION I

Prepared for:

U.S. Environmental Protection Agency
Region I
Office of Site Remediation and Restoration
Boston, MA 02114-2023

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TtNUS PROJECT NO. N0308-0600
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Submitted by:

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and
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 CONCORD, MASSACHUSETTS

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SITE DESCRIPTION

The Nuclear Metals, Inc. (NMI) facility is located on a 46.4-acre parcel at 2229 Main Street in Concord, Middlesex County, Massachusetts (Figure 1) [3; 24; 42, pp. 2, 21]. The geographic coordinates of the property, as measured from the center of the on-site interconnected buildings, are latitude 42° 26' 30.0" north and longitude 71° 25' 19.0" west [64]. NMI consists of Parcel No. 2970-1 listed on Concord Tax Assessor Map No. B12 [24]. The facility includes five interconnected buildings, a paved parking area, a sphagnum bog, a cooling water recharge pond, and a holding basin (Figure 2) [40, p. 3, Fig. 2; 65, p. 11]. The NMI facility currently operates as Starmet Corporation (Starmet) [79].

The topography of the property slopes down to the north [3]. The property is bordered to the north by Main Street, commercial and residential properties, and the Assabet River; to the east by woodland and residential properties; to the west by woodland and commercial/industrial properties; and to the south by woodland and residential properties [40, p. 3, Fig. 2].

In 1958, NMI began operating a manufacturing facility on previously undeveloped land [50, p. 4]. They produced depleted uranium products, primarily as penetrators for armor piercing ammunition. NMI also manufactured metal powders for medical applications, photocopiers, and specialty metal products, such as beryllium tubing used in the aerospace industry [42, pp. 2, 21].

From 1958 to 1985, NMI discharged wastes to an unlined holding basin. Cast depleted uranium ingots or billets were jacketed, sealed, and evacuated in copper cans, which were then heated and extruded into long rod stock. The extruded depleted uranium rod had a resulting thin layer of copper coating which was removed in a nitric acid pickling operation. During the pickling process, "small quantities" of copper and uranium were dissolved in the nitric acid. The spent nitric acid solution was collected, neutralized with a lime slurry, and then discharged to the unlined, in-ground holding basin. "Small quantities" of other specialty metal products including steel jacketed beryllium, stainless steel, and titanium alloys were also pickled at various times with several different acids (nitric, hydrofluoric, hydrochloric, and sulfuric), and discharged to the holding basin. The discharge to the holding basin ceased in 1985 when NMI began using an acid closed-loop recycling process [43, p. 1-6].

In addition to natural and depleted uranium (as elemental, oxide, and fluoride), NMI handled thorium and thorium oxide under license to the Nuclear Regulatory Commission (NRC); sulfuric and nitric acids for process activities; 1,1,1-trichloroethane as a solvent; trichlorofluoroethane as a degreaser; zirconium; magnesium; beryllium; acetone; hydrogen peroxide; flammable gases (propane and acetylene); and oxygen. Two 10,000-gallon underground storage tanks were used for the storage of No. 4 fuel oil. Several of the following oils were used and recycled on site: DTE light, DTE heavy, Medium DTE 25, vacuum oil (HEISO), and No. 7d [66, p. 5].

On October 1, 1997, Nuclear Metals, Inc. was renamed Starmet Corporation [79]. In March 1997, the company's license to handle source material (including depleted uranium, thorium, and thorium oxide) under the NRC was transferred to the Massachusetts Department of Public Health [9]. In accordance with Massachusetts state license SM-0179, Starmet is allowed to use source material (including depleted uranium, thorium, and thorium oxide) to manufacture, research, develop, and distribute metallic products in a variety of forms including castings, extensions, and metal powders [9]. Starmet continues to conduct a variety of metallurgical tasks including: extrusions, beryllium aluminum alloy investment coatings, and depleted uranium processing. According to Starmet, one-third of Starmet's core business is producing specialty metal powder using a rotating electrode process [79].

HRS DOCUMENTATION RECORD--REVIEW COVER SHEET

Name of Site Nuclear Metals, Inc.(NMI)

Contact Persons

Site Investigation: David Gorden/Dynamac Corporation (978) 658-7899
Kathleen Jalkut/TtNUS

Documentation Record: Nancy Smith/EPA Region I (617) 918-1436

Pathways, Components, or Threats Not Scored

The calculation of the HRS site score for the NMI site is based on threats posed by the site to the ground water migration and surface water migration pathways. After a review of the four pathways, it was determined that the soil exposure and the air migration pathways do not contribute significantly to the overall HRS site score. The soil exposure pathway lacked actual contamination targets and the air migration pathway lacked an observed release. Therefore, these two pathways have not been included in this HRS package.

HRS DOCUMENTATION RECORD

Name of Site: Nuclear Metals, Inc.

EPA Region: I

Date Prepared: July 19, 2000

Street Address of Site: 2229 Main Street, Concord

County and State: Middlesex County, Massachusetts

General Location in the State: East Central

Topographic Map: US Geological Survey. 1987. 1:25,000 Scale Metric Topographic
Map for Maynard, Massachusetts

Latitude: 42° 26' 30.0" north

Longitude: 71° 25' 19.0" west

Air Pathway	Not scored
Ground Water Pathway	100
Soil Exposure Pathway	Not scored
Surface Water Pathway	60
HRS SITE SCORE	58.31

WORKSHEET FOR COMPUTING HRS SITE SCORE

	<u>S</u>	<u>S²</u>
1. Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	<u>100</u>	<u>10,000</u>
2a. Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	<u>60</u>	
2b. Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	<u>NS</u>	
2c. Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	<u>60</u>	<u>3,600</u>
3. Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	<u>NS</u>	<u>NS</u>
4. Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	<u>NS</u>	<u>NS</u>
5. Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$		<u>13,600</u>
6. HRS Site Score Divide the value on line 5 by 4 and take the square root	<u>58.31</u>	

NS = Not scored

TABLE 3-1
GROUND WATER MIGRATION PATHWAY SCORESHEET

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>
<u>Likelihood of Release</u>			
1.	Observed Release	550	550
2.	Potential to Release		
2a.	Containment	10	NS
2b.	Net Precipitation	10	NS
2c.	Depth to Aquifer	5	NS
2d.	Travel Time	35	NS
2e.	Potential to Release		
	[lines 2a x (2b+2c+2d)]	500	NS
3.	Likelihood of Release (higher of lines 1 and 2e)	550	550
<u>Waste Characteristics</u>			
4.	Toxicity x Mobility	a	1E+04
5.	Hazardous Waste Quantity	a	100
6.	Waste Characteristics	100	32
<u>Targets</u>			
7.	Nearest Well	50	20
8.	Population		
8a.	Level I Concentrations	b	0
8b.	Level II Concentrations	b	0
8c.	Potential Contamination	b	819
8d.	Population (lines 8a+8b+8c)	b	819
9.	Resources	5	5
10.	Wellhead Protection Area	20	20
11.	Targets (lines 7+8d+9+10)	b	844
<u>Ground Water Migration Score for an Aquifer</u>			
12.	Aquifer Score [(lines 3 x 6 x 11)/82,500]	100	100
<u>Ground Water Migration Pathway Score</u>			
13.	Pathway Score (S_{gw})	100	100
"a" = maximum value applicable. "b" = maximum value not applicable.			
"c" = Do not round to nearest integer. NS = not scored.			

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>
DRINKING WATER THREAT			
<u>Likelihood of Release</u>			
1.	Observed Release	550	550
2.	Potential to Release by Overland Flow		
2a.	Containment	10	NS
2b.	Runoff	25	NS
2c.	Distance to Surface Water	25	NS
2d.	Potential to Release by Overland Flow (Lines 2a x [2b+2c])	500	NS
3.	Potential to Release by Flood		
3a.	Containment (Flood)	10	NS
3b.	Flood Frequency	50	NS
3c.	Potential to Release by Flood (lines 3a x 3b)	500	NS
4.	Potential to Release (lines 2d+3c) subject to a maximum of 500	500	NS
5.	Likelihood of Release (higher of lines 1 and 4)	550	550
<u>Waste Characteristics</u>			
6.	Toxicity x Persistence	a	1E+04
7.	Hazardous Waste Quantity	a	100
8.	Waste Characteristics	100	32

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET
Drinking Water Threat Score (continued)

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>
<u>Targets</u>			
9.	Nearest Intake	50	0
10.	Population		
10a.	Level I Concentrations	b	0
10b.	Level II Concentrations	b	0
10c.	Potential Contamination	b	0
10d.	Population (lines 10a+10b+10c)	b	0
11.	Resources	5	0
12.	Targets (lines 9+10d+11)	b	0
13.	Drinking Water Threat Score ([lines 5 x 8 x 12]/82,500) subject to a maximum of 100	100	0
HUMAN FOOD CHAIN THREAT			
<u>Likelihood of Release</u>			
14.	Likelihood of Release (same value as line 5)	550	550
<u>Waste Characteristics</u>			
15.	Toxicity x Persistence x Bioaccumulation	a	5E+08
16.	Hazardous Waste Quantity	a	100
17.	Waste Characteristics	1,000	320

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET
Human Food Chain Threat Score (continued)

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>
<u>Targets</u>			
18.	Food Chain Individual	50	0
19.	Population		
19a.	Level I Concentrations	b	0
19b.	Level II Concentrations	b	0
19c.	Potential Contamination	b	0
19d.	Population (lines 19a+19b+19c)	b	0
20.	Targets (lines 18+19d)	b	0
21.	Human Food Chain Threat Score ([lines 14 x 17 x 20]/82,500) subject to a maximum of 100	b	0
			0
ENVIRONMENTAL THREAT			
<u>Likelihood of Release</u>			
22.	Likelihood of Release (same value as line 5)	550	550
<u>Waste Characteristics</u>			
23.	Ecosystem Toxicity x Persistence x Bioaccumulation	a	5E+08
24.	Hazardous Waste Quantity	a	100
25.	Waste Characteristics	1,000	320

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET
Environmental Threat Score (continued)

<u>Factor Categories and Factors</u>		<u>Maximum Value</u>	<u>Value Assigned</u>
<u>Targets</u>			
26.	Sensitive Environments		
26a.	Level I Concentrations	b	300
26b.	Level II Concentrations	b	NS
26c.	Potential Contamination	b	0
26d.	Sensitive Environments (lines 26a+26b+26c)	b	300
27.	Targets (value from line 26d)	b	300
28.	Environmental Threat Score ([lines 22 x 25 x 27]/82,500) subject to a maximum of 60	60	60
			60

SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE FOR A WATERSHED

29.	Watershed Score (c) (lines 13+21+28) subject to a maximum of 100	100	60
30.	Component Score (c) (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	60

"a" = maximum value applicable.
 "b" = maximum value not applicable.
 "c" = do not round to nearest integer.
 NS = not scored.

NOTES TO THE READER

All reference citations used to document the HRS score will utilize the following conventions:

- [31] = Reference No. 31 (all references cited by number)
- “;” = Next reference
- [3-5] = Multiple references including reference 3, 4, and 5
- Vol. = Volume
- p. = Single page (Example: p. 6 or p. 5-2)
- pp. = Multiple pages
(Example: pp. 4-6 or pp. 1-3 to 1-4 or pp. 2 to 4)
- App. = Appendix
- Tab. = Table
- Fig. = Figure

For example: The sphagnum bog, located east of the holding basin, is a vegetated wetland [12, p. 4-2; 19, Fig. 4; 28, App. 2; 36-38; 42, p. 6].

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<u>Reference Number</u>	<u>Description of the Reference</u>
[80]	Gorden, D. (Dynamac Corporation). 2000. Telephone Conversation Record with Sara Hanna (GZA GeoEnvironmental, Inc.), RE: Quality of GZA Laboratory Data. April 20. 1 p.
[81]	Gorden, D. (Dynamac Corporation). 1999. Telephone Conversation Record with Chris Pyott (Massachusetts Department of Environmental Protection), RE: Documenting a Fishery in the Assabet or Concord Rivers. December 8. 1 p.
[82]	Reference reserved.
[83]	Hanna, S. (GZA GeoEnvironmental, Inc.). 2000. Facsimile, RE: Sample Quantitation Limits. March 27. 2 pp.
[84]	Hanna, S. (GZA GeoEnvironmental, Inc.). 2000. Facsimile, RE: Sample Quantitation Limits. April 3. 2 pp.
[85]	http://www.chemlab.pc.maricopa.edu/periodic/decay.fcgi?u-232 . Printout date: April 25,2000, RE: Uranium-232 Isotope Decay.
[86]	http://www.chemlab.pc.maricopa.edu/periodic/decay.fcgi?u-234 . Printout date: April 25,2000, RE: Uranium-234 Isotope Decay.
[87]	http://www.chemlab.pc.maricopa.edu/periodic/decay.fcgi?u-236 . Printout date: April 25,2000, RE: Uranium-236 Isotope Decay.
[88]	GZA GeoEnvironmental, Inc. 1997. <u>Groundwater Monitoring Report, 1996-1997, 2229 Main Street, Concord, Massachusetts</u> . November. 14 pp.
[89]	GZA GeoEnvironmental, Inc. 2000. Holding Basin Soil Characterization Study, Starmet Corporation, 2229 Main Street, Concord, Massachusetts. May. 8 pp., 1 Tab.
[90]	GZA GeoEnvironmental, Inc. 1998. Intermediate Survey Report and Evaluation of Substantial Release Migration, Release Abatement Measure, Starmet Corporation, 2229 Main Street, Concord, Massachusetts. December. 13 pp., 4 Tab.
[91]	GZA GeoEnvironmental, Inc. 1996. Supplemental Phase II Field Investigation, Nuclear Metals, Inc., 2229 Main Street, Concord, Massachusetts (Surface Soil Sample Analytical Results). December. 5 pp.
[92]	Gorden, D. (Dynamac Corporation). 1999. Telephone Conversation Record with Chris Pyott (Massachusetts Department of Environmental Protection), RE: Laboratory Labeling of Monitoring Well GZW-5. July 29. 1 p.

OTHER POSSIBLE SOURCES

The following possible sources have been identified during previous investigations; however, insufficient information exists to score these sources. Therefore, they have not been used in this HRS package for purposes of scoring.

Area Between Building C and Boring GZW-7

A nitric acid storage tank (size unknown) was formerly located in an unpaved area between Building C and boring GZW-7. Additionally, beryllium, graphite, and machine oils were formerly stored (container type unknown) in an unpaved area between Building C and boring GZW-7 (Figure 2) [52, p. 3].

Black Powder on Bank

In 1991, NMI identified a black powdery material beneath the "leaf mold and pine needles" that covered the sand and gravel of a bank located southeast of the on-property buildings. According to NMI, the material appeared to be a carbon-based powder such as coke or coal dust or powdered graphite. NMI reported that the material was "slightly radioactive" at four to five times natural background [46, p. 1]. NMI reported after interviewing long term employees that the material most likely came from a graphite machining operation which terminated in the mid 1960s [46, p. 3].

Boiler Room Sump

In 1990, NMI personnel reported that approximately 5 gallons of No. 6 fuel oil was released from within the facility's boiler room. NMI reported that the fuel oil entered a sump which periodically discharged into the cooling water recharge pond [77, p. 21].

Buildings C and D

Portions of Buildings C and D were formerly used as machine shops. Materials used in these areas included depleted uranium and cutting oils [52, p. 3]. Uranium was detected in soil samples collected below the slab of the former Machine Shop Annex in Building C and from the bottom of the "grounding rod" in Building D (Figure 2) [77, p. 10, Tab. 2]. The "grounding rod", a 2-inch diameter copper pipe, was installed in the mid- to late 1980s as a possible solution to machine electrical problems experienced by NMI [77, pp. 10, 20].

Former Waste Storage Area

Prior to the construction of Building E, a portion of the land in this area was used for waste storage. The former waste storage area extended to the southeast of Building E (Figure 2). Runoff from the former waste storage area reportedly flowed to on-site depressions, located to the south and southeast. Materials which may have been stored in this area included depleted uranium, copper, beryllium, machining oils, coolants, and solvents [52, p. 2].

Old Landfill

A landfill located to the south of the sphagnum bog was reportedly used for the disposal of solid waste by NMI and local residents [52, p. 3]. Most of the material reportedly placed in the old landfill consists of laboratory hoods and furniture, concrete blocks, tires, and "similar materials" [67, App. H, pp. 1-2; 52, p. 3]. Material described as "graphite", which was reported to contain beryllium, zirconium, molybdenum, titanium, and/or copper was reportedly present in the western portion of the old landfill [52, p. 3]. A geophysical survey was conducted in the old landfill. Data from the 1-acre survey area of the old landfill identified 13 anomalies, of which GZA GeoEnvironmental, Inc. (GZA) "reasonably" attributed 11 to the presence (interference) of surficial metallic or non-ferrous objects [67, App. H, p. 4].

Process Drain Lines

During a video camera survey of on-site process drains and wastewater lines conducted in 1997, solid material, apparently sludge, was encountered in some of the pipe sections [52, p. 4]. In other pipe sections, the view was obscured by liquid flowing through the line at the time of the survey [52, p. 4]. GZA reported that two drain lines formerly discharged to the sphagnum bog. Additionally, GZA reported that both outfall pipes and the former connections to buildings have been removed. According to GZA, the middle portions of the pipes are believed to remain at the site [52, p. 5].

Septic System Leachfield

NMI utilized an on-site septic system. Roy F. Weston, Inc. reported that liquids washed from surfaces within the facility often "ended up" in the septic system [66, p. 1]. GZA sampled the liquid from Septic Tank 1 (ST1) and Septic Tank 2 (ST2) from the on-site septic system [88, p. 11]. Laboratory data identified the presence of acetone; 2-butanone; carbon disulfide; chlorobenzene; 1,1-dichloroethane; ethylbenzene; methylene chloride; titanium; toluene; 1,1,1-trichloroethane; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; -, o-, and p-xylene; and copper in samples collected from ST1 and ST2 [69-76; 88, p. 11].

Sweepings Fill Area

The sweepings fill area is located south of the NMI buildings [52, p. 4]. GZA reported that sweepings from the NMI facility were disposed of in this area [49, p. 9]. As part of a Phase II investigation, GZA collected soil samples from this area. Uranium was detected in soil samples at concentrations ranging from 8.51 to 175 parts per million (ppm) [52, p. 4; 77, p. 23].

SOURCE DESCRIPTION

2.2 Source Characterization

Number of the source: 1

Name and description of the source: Holding Basin (Surface Impoundment)

The unlined holding basin was constructed in 1958 and was used from 1958 through 1985 [42, p. 3; 43, p. 1-6]. NMI discharged process waste (lime-neutralized spent nitric acid pickling liquor) containing copper and uranium as insoluble oxide and hydroxide compounds to the holding basin [43, pp. 1-6, 2-2]. The primary constituents of the mixed oxide/hydroxide material in the holding basin were copper and magnesium hydroxides, and calcium diurnate [43, p. 3-5]. The discharge to the holding basin ceased in 1985 when NMI began using an acid closed-loop recycling process [43, p. 1-6]. Since 1985, no liquid process wastes have been released to the holding basin [42, p. 4].

Additionally, NMI discharged the supernatant from the waste to the sphagnum bog; however, this practice was discontinued after a "brief use" [51, p. 19]. Available information does not indicate the period of time that the supernatant was piped to the sphagnum bog.

Available information documents conflicting dimensions for the holding basin:

In a February 1993 report, NMI noted that the holding basin's maximum dimensions were approximately 180 feet by 100 feet. NMI reported that the holding basin's surface area at that time was approximately 13,500 square feet. The average depth of the sludge was estimated to be 8 feet. The maximum depth of the sludge was estimated to be 12.5 feet [50, p. 11].

In a January 1997 report, NMI reported that the volume of the entire waste in the holding basin, including a submerged bar, edge overfill, floor interface, and surrounding soil was approximately 4,823 cubic yards [43, pp. 3-15 to 3-16]. The surface area of the basin was reported to be 13,240 square feet with an average depth of 5.74 feet [43, p. 3-14].

In a February 1997 report, GZA noted that the holding basin covered approximately 14,000 square feet. Measured depths of the holding basin ranged from less than 1 foot to 13 feet [41, p. 3].

On April 13, 1999, NMI reported that a total of 8,009 cubic yards of holding basin contents had been removed from the site and shipped to a licensed disposal facility in Utah [40, p. 4; 68].

In November/December 1999, GZA completed 60 additional borings in and around the Holding Basin and analyzed the boring samples for uranium. Boring sampling results indicated that the highest uranium concentrations were present in the southwest corner of the Holding Basin. GZA determined that the average concentration of uranium in the Holding Basin during November/December 1999 was 215 ppm [89, p. 6].

Location of the source, with reference to a map of the site:

The holding basin is located on the southern portion of the NMI site, southeast of the on-property buildings, 75 feet south of the cooling water recharge pond, and 75 feet southwest of the sphagnum bog [3; 40, Fig. 2]. Figure 2 depicts the holding basin with respect to the other sources located at the site.

Containment

The unlined holding basin was constructed in 1958 and initially conformed to a natural steep sided kettle hole. The holding basin was enlarged by removing soil from the base of the sidewalls and by constructing an earthen dike on its northern face [42, p. 3; 43, p. 3-1; 50, p. 4].

Two recorded incidents involving spills occurred at the holding basin. On January 26, 1982, a small hole in the dike developed, and approximately 30 gallons of liquid containing less than 5 pounds of depleted uranium collected in a shallow depression on the "other side of the dike" on NMI's property [50, p. 7].

Additionally, on April 10, 1986, a pump failure resulted in the release of an estimated 2,400 gallons of slightly acidic waste water onto the floor of an acid treatment building, and the immediately adjacent soil. The spill reportedly occurred within a fenced area that surrounded the holding basin at that time. The waste water contained approximately 40 pounds of depleted uranium [50, p. 7].

An impermeable, 36-mil thick, Hypalon® cover was installed over the holding basin in December 1986. The cover was installed both to prevent precipitation infiltration through basin contaminants and to prevent the potential for wind borne fugitive dust. The cover was removed when the sludge was excavated in the summer of 1997 [40, p. 4; 42, p. 4].

During the summer of 1997, a temporary structure was erected over the holding basin. Excavation of holding basin sludge and sub-basin soils began in the fall of 1997. The temporary structure was removed in the spring of 1998, and additional areas which could not be accessed when the structure was present were also excavated [40, p. 4].

The holding basin is an unlined, in-ground structure [43, p. 1-6]. There is no evidence of a functioning, maintained, run-on control and run off management system or a functioning leachate collection and removal system for this surface impoundment source [3; 40, Fig. 3; 42, p. 3; 1, pp. 51596, 51609, Tab. 3-2 and Tab. 4-2]. Therefore, a containment factor of 10 has been assigned [1, pp. 51596, 51609, Tab. 3-2 and Tab. 4-2].

2.4.1 Hazardous Substances

The Site Characterization Report for the Holding Basin (February 1993) notes that NMI collected sample No. 44689 from the holding basin. Sample No. 44689 was analyzed for arsenic, calcium, copper, uranium, ²¹⁰lead, ²²⁶radium, and ²³⁰thorium [50, p. 18, Tab. 3.2].

In March 1998, GZA, contractor for Starmet, collected samples from the holding basin. GZA analyzed the holding basin samples for arsenic and copper by EPA Method 6010 [61, pp. 1-4]. Uranium was analyzed fluorometrically according to a sodium fluoride, lithium fluoride fusion method [28].

The Phase III Holding Basin RAM Completion Feasibility Study (January 1999) notes that GZA analyzed holding basin sludge and soil samples for depleted uranium, copper, and nitrate. GZA concluded that depleted uranium, which is composed primarily of ²³⁸uranium, was present at the site. Depleted uranium is produced as a byproduct when ²³⁵uranium is extracted from natural uranium ore. In holding basin sample SB-8, ²³⁵uranium was detected at 12,000 ppm [40, pp. 6-8, Fig. 3].

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

The following table summarizes the CERCLA hazardous substances associated with the holding basin (Source 1) at the NMI site based on analytical results.

Hazardous substance	Evidence (Sample No.)	Reference
arsenic	SB-5,S-1C	[40, Fig. 3; 61, p. 1; 90, Tab. 2]
arsenic	44689	[50, Tab. 3.2, p. 18]
calcium	44689	[50, Tab. 3.2, p. 18]
copper	44689	[50, Tab. 3.2, p. 18]
copper	SB-5,S-1C	[40, Fig. 3; 61, p. 1; 90, Tab. 2]
uranium	44689	[50, Tab. 3.2, p. 18]
uranium	SB-9,S-1B	[40, Fig. 3; 61, p. 3; 90, Tab. 2]
²¹⁰ lead	44689	[50, Tab. 3.2, p. 18]
²²⁶ radium	44689	[50, Tab. 3.2, p. 18]
²³⁰ thorium	44689	[50, Tab. 3.2, p. 18]
²³⁵ uranium	SB-8	[40, pp. 7]

Note: Sample No. 44689 is listed in Reference 50 as being collected in the northern portion of the holding basin [50, p. 18]. A figure identifying its location was not present with Reference 50.

From 1958 to 1985, NMI discharged process wastes described as a mixed oxide/hydroxide material to an unlined holding basin [43, p. 1-6, 3-5].

The following table summarizes the CERCLA hazardous substances associated with the holding basin (Source 1) at the NMI site based on operational processes.

Hazardous substance	Reference
acetone	[66, p. 5]
beryllium	[66, p. 5]
calcium	[43, p. 3-5]
copper	[41, p. 3]
²³⁵ uranium	[66, p. 5]
hydrochloric acid	[43, p. 1-6]
magnesium	[66, p. 5]
uranium	[66, p. 5]
nitric acid	[66, p. 5]
sulfuric acid	[43, p. 1-6; 66, p. 5]
thorium	[66, p. 5]
1,1,1-trichloroethane	[66, p. 5]

2.4.2. Hazardous Waste Quantity

The Hazardous Waste Quantity for Source No. 1 was calculated based on the Area Assigned Value of Source No. 1. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source No. 1 because sufficient information was not available [1, pp. 51591, 51647].

2.4.2.1.4. Area

Available information documents conflicting dimensions for the holding basin. In a February 1993 report, NMI noted that the holding basin's maximum dimensions were approximately 18,000 square feet. NMI reported that the holding basin's surface area at that time was approximately 13,500 square feet [50, p. 11].

In the January 1997 NMI Decommissioning Plan for the Holding Basin, NMI reported that the surface area of the basin was 13,240 square feet [43, p. 3-14].

In a February 1997 report, GZA noted that the holding basin covered approximately 14,000 square feet [41, p. 3].

A contractor to EPA estimated the area of the holding basin at 18,225 square feet using Figure 3 (Holding Basin Site Exploration Location Plan), located in Reference 40, and an overlaid grid. The map scale is 1 inch is equal to 30 feet and the grid scale is 1 box is equal to 56.25 square feet. Using the overlay, the holding basin occupied 324 boxes. Three hundred twenty-four boxes multiplied by 56.25 square feet per box is equal to 18,225 square feet [29; 40, Fig. 3].

For the purpose of this HRS package, the contractor to EPA will use NMI's reported holding basin area, 13,240 square feet, the smallest reported area, as the Area of Source [43, p. 3-14].

Area of source (ft²): 13,240

Reference(s): [43, p. 3-14]

The area of the surface impoundment source, in square feet, is divided by 13 to determine the Area Assigned Value [1, p. 51591, Tab. 2-5].

13,240 square feet ÷ 13 = 1,018.46

Area Assigned Value: 1,018.46

2.4.2.1.5. Source Hazardous Waste Quantity Value

The Hazardous Waste Quantity was calculated based on the Area Assigned Value of Source No. 1. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source No. 1 because sufficient information was not available [1, p. 51591].

Source Hazardous Waste Quantity Value: 1,018.46

SOURCE DESCRIPTION

2.2 Source Characterization

Number of the source: 2

Name and description of the source: Cooling Water Recharge Pond (Surface Impoundment)

The unlined cooling water recharge pond received non-contact cooling water from the NMI facility [52, p. 5]. NMI obtains ground water from two on-site supply wells (SW-1, SW-2A) for use as process water and cooling water [40, Fig. 2; 66, p. 8]. Non-contact cooling water is discharged to the cooling water recharge pond in accordance with Massachusetts Ground Water Discharge Permit No. 092 [51, p. 12]. Available information did not indicate the number of years of discharge.

The following substances have been detected in ground water samples collected from SW-1 and/or SW-2A at concentrations greater than or equal to the sample quantitation limit: tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, iron, copper, and manganese [40, Fig. 2; 54, p. 12; 55, pp. 21, 22, 36, 39; 55, p. 1]. Refer to the ground water migration pathway section of this HRS package for additional information regarding monitoring wells.

Precipitation, which does not infiltrate the ground surface, flows overland and enters the cooling water recharge pond, based on property topography [52, p. 5].

Location of the source, with reference to a map of the site:

The cooling water recharge pond is located in the central portion of the NMI site, east of the on-property buildings, 75 feet north of the holding basin, and 75 feet northwest of the sphagnum bog [3; 40, Fig. 2]. Figures 2 and 3 depict the cooling water recharge pond with respect to the other sources located at the site.

Containment

The cooling water recharge pond is in a natural topographic depression [3]. There is no evidence of a functioning, maintained run-on control and run off management system or a functioning leachate collection and removal system for this cooling water recharge pond source [35; 52, p. 6; 1, pp. 51596, 51609, Tab. 3-2 and Tab. 4-2]. Therefore, a containment factor of 10 has been assigned [1, pp. 51596, 51609, Tab. 3-2 and Tab. 4-2].

2.4.1 Hazardous Substances

In April 1995, GZA, contractor for NMI, collected ground water samples from supply wells SW-1 and SW-2A. GZA analyzed the ground water samples for metals by EPA Method 6010 [59, p. 1].

In October 1996, GZA collected a ground water sample from supply well SW-1. GZA analyzed the ground water sample for VOCs by EPA Method 8260 and metals by EPA Method 6010 [54, pp. 12-14].

In April 1998, GZA collected ground water samples from supply wells SW-1 and SW-2A. GZA analyzed the ground water samples for VOCs by EPA Method 8260 and metals by EPA Method 6010 [55, pp. 20-22, 35-40].

In July 1998, GZA collected sediment samples CWP-SED1 through CWP-SED4 from the cooling water recharge pond. GZA analyzed the sediment samples for VOCs by EPA Method 8260, extractable petroleum hydrocarbons and polynuclear aromatic hydrocarbons by MADEP methods, copper by EPA Method 7211, and uranium by ASTM Method D5174 [11; 60, pp. 1-6; 77, p. 12, Tab. 2, Fig. 2A].

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

The following table summarizes the CERCLA hazardous substances associated with the cooling water recharge pond (Source 2) at the NMI site based on analytical results from sediment samples.

Hazardous substance	Evidence (Sample No.)	Reference
anthracene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
benzo(a)anthracene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
benzo(a)pyrene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
benzo(b)fluoranthene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
benzo(ghi)perylene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
benzo(k)fluoranthene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
chrysene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
copper	CWP-SED3	[60, p. 7; 77, Fig. 2A]
fluoranthene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
indeno(123-cd)pyrene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
naphthalene	CWP-SED4	[60, p. 10; 77, Fig. 2A]
phenanthrene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
pyrene	CWP-SED1	[60, p. 1; 77, Fig. 2A]
uranium	CWP-SED2	[60, p. 11; 77, Fig. 2A]

NMI obtains non-contact cooling water from ground water supply wells SW-1 and SW-2A, located on the NMI site [40, Fig. 2]. Non-contact cooling water is discharged to the cooling water recharge pond in accordance with Massachusetts Ground Water Discharge Permit No. 092 [51, p. 12].

The property is located in a mixed residential area. To the north is Main Street with commercial and residential properties, and the Assabet River. To the east are woodland and residential properties. To the west are woodland and commercial/industrial properties. To the south are woodland and residential properties [3; 40, p. 3, Fig. 2]. No alternative anthropogenic sources of hazardous substance contamination in ground water wells SW-1 or SW-2A have been identified.

The following table summarizes the CERCLA hazardous substances associated with the cooling water recharge pond (Source 2) at the NMI site based on analytical results from ground water supply well samples.

<u>Hazardous substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
tetrachloroethene	SW-1	[55, p. 36]
1,1,1-trichloroethane	SW-2A	[55, p. 39]
trichloroethene	SW-2A	[55, p. 21]
copper	SW-1	[54, p. 12]
iron	SW-2A	[59, p. 1]
manganese	SW-2A	[55, p. 22]

2.4.2. Hazardous Waste Quantity

The Hazardous Waste Quantity for Source No. 2 was calculated based on the Area Assigned Value of Source No. 2. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source No. 2 because sufficient information was not available [1, pp. 51591, 51647].

2.4.2.1.4. Area

Dimensions for the cooling water recharge pond were not identified in available information.

A contractor to EPA estimated the area of the cooling water recharge pond at 31,250 square feet using Figure 2 (Exploration Location Plan of Site and Vicinity), located in Reference 40, and an overlaid grid. The map scale is 1 inch is equal to 100 feet and the grid scale is 1 box is equal to 625 square feet. Using the overlay, the cooling water recharge pond occupied 50 boxes. Fifty boxes multiplied by 625 square feet per box is equal to 31,250 square feet [30; 40, Fig. 2].

Area of source (ft²): 31,250

Reference(s): [30; 40, Fig. 2]

The area of the surface impoundment source, in square feet, is divided by 13 to assign an Area Assigned Value to the source [1, p. 51591, Tab. 2-5].

31,250 square feet ÷ 13 = 2,403.85

Area Assigned Value: 2,403.85

2.4.2.1.5. Source Hazardous Waste Quantity Value

The Hazardous Waste Quantity was calculated based on the Area Assigned Value of Source No. 2. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source No. 2 because sufficient information was not available [1, p. 51591].

Source Hazardous Waste Quantity Value: 2,403.85

SOURCE DESCRIPTION

2.2 Source Characterization

Number of the source: 3

Name and description of the source: Contaminated soil (Contaminated soil)

This source is a 350,000 square foot area of contaminated soil. This area was determined by surface soil sample analytical results from the following sample locations: BG-2, BG-3, OF-2, GZ-207, GZ-203, GR-3, GS-14, GS-15, GS-16, OF-1, GS-10, GS-7, OF-3, and DL-2. This source does not include the area of the holding basin (source 1), the cooling water recharge pond (source 2), the sphagnum bog, the on-property buildings, or the paved areas [31; 63, pp. 1-11].

As part of a 1996 Supplemental Phase II Field Investigation and a 1998 Additional Phase II Field Investigation, GZA collected surface soil samples throughout the NMI property. Surface soil samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8260, extractable petroleum hydrocarbons and polynuclear aromatic hydrocarbons by MADEP methods, metals by EPA Method 6010, and uranium by ASTM Method D5174 [11; 63, pp. 1-19; 65, Tab. 7; 77, Tab. 2; 91, pp. 1-5].

Location of the source, with reference to a map of the site:

The contaminated soil is located across the NMI site and is delineated by the following surface soil sampling locations: BG-2, BG-3, OF-2, GZ-207, GZ-203, GR-3, GS-14, GS-15, GS-16, OF-1, GS-10, GS-7, OF-3, and DL-2 [31; 63, pp. 1-19; 65, Tab. 7; 77, Tab. 2; 91, pp. 1-5]. Figure 4 depicts the area of the contaminated soil source.

Containment

There is no evidence of a functioning, maintained run-on control and run off management system or a functioning leachate collection and removal system for this contaminated soil source [3; 35; 1, pp. 51596, 51609, Tab. 3-2 and 4-2]. Therefore, a containment factor of 10 has been assigned [1, p. 51609, Tab. 4-2, p. 51596, Tab. 3-2].

2.4.1 Hazardous Substances

An Environmental Survey of NMI report (February 1983) notes that 41 surface soil samples were collected across the Nuclear Metals Inc property and analyzed for ²³⁵uranium, ²³⁸uranium, and ²³²thorium [40, Fig. 2; 62, pp. 1-2].

In August 1996, GZA, contractor for NMI, collected surface soil samples across the NMI property. GZA analyzed the surface soil samples for metals by EPA Method 6010 [40, Fig. 2; 91, pp. 1-5].

In June and July 1998, GZA collected surface soil samples across the NMI property. GZA analyzed the surface soil samples for VOCs by EPA Method 8260, extractable petroleum hydrocarbons and polynuclear aromatic hydrocarbons by MADEP Methods, metals by EPA Methods 6010, 6010A, and total uranium by ASTM Method D5174 [11; 40, Fig. 2; 63, pp. 1-19].

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

The following table summarizes the CERCLA hazardous substances associated with the area of contaminated soil (Source 3) at the NMI site based on analytical results from surface soil samples.

Hazardous Substance	Evidence (Sample No.)	Reference
benzo(a)anthracene	DL5-S1	[40, Fig. 2; 63, p. 7]
benzo(a)pyrene	DL5-S1	[40, Fig. 2; 63, p. 7]
benzo(b)fluoranthene	DL5-S1	[40, Fig. 2; 63, p. 7]
benzo(ghi)perylene	DL5-S1	[40, Fig. 2; 63, p. 7]
benzo(k)fluoranthene	DL5-S1	[40, Fig. 2; 63, p. 7]
chrysene	DL5-S1	[40, Fig. 2; 63, p. 7]
fluoranthene	DL5-S1	[40, Fig. 2; 63, p. 7]
indeno(123-cd)pyrene	DL5-S1	[40, Fig. 2; 63, p. 7]
phenanthrene	DL5-S1	[40, Fig. 2; 63, p. 7]
pyrene	DL5-S1	[40, Fig. 2; 63, p. 7]
arsenic	BG-3	[40, Fig. 2; 63, p. 1]
beryllium	GR-3	[40, Fig. 2; 63, p. 12]
beryllium	GS-14	[40, Fig. 2; 91, p. 3]
beryllium	GS-15	[40, Fig. 2; 91, p. 4]
beryllium	OF-2	[40, Fig. 2; 63, p. 3]
beryllium	GS-16	[40, Fig. 2; 91, p. 5]
beryllium	OF-1	[40, Fig. 2; 63, p. 2]
beryllium	GS-10	[40, Fig. 2; 91, p. 2]
beryllium	GS-7	[40, Fig. 2; 91, p. 1]
beryllium	DR-4	[40, Fig. 2; 63, p. 9]

<u>Hazardous Substance</u>	<u>Evidence (Sample No.)</u>	<u>Reference</u>
copper	BG-2	[40, Fig. 2; 63, p. 17]
copper	GZ-203	[40, Fig. 2; 63, p. 13]
copper	OF-3	[40, Fig. 2; 63, p. 4]
copper	GR-3	[40, Fig. 2; 63, p. 12]
copper	GZ-207	[40, Fig. 2; 63, p. 16]
copper	OF-2	[40, Fig. 2; 63, p. 3]
copper	BG-3	[40, Fig. 2; 63, p. 1]
copper	OF-1	[40, Fig. 2; 63, p. 2]
copper	DL-2	[40, Fig. 2; 63, p. 19]
magnesium	DR-3	[40, Fig. 2; 63, p. 8]
molybdenum	DR-4	[40, Fig. 2; 63, p. 9]
uranium	GR-3	[40, Fig. 2; 63, p. 10]
²³⁵ uranium	18	[62, pp. 1-2]
²³⁸ uranium	18	[62, pp. 1-2]

2.4.2. Hazardous Waste Quantity

The Hazardous Waste Quantity for Source No. 3 was calculated based on the Area Assigned Value of Source No. 3. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source No. 3 because sufficient information was not available [1, pp. 51591, 51647].

2.4.2.1.4. Area

A contractor to EPA estimated the area of the contaminated soil source at 395,000 square feet using Figure 2 (Exploration Location Plan of Site and Vicinity), located in Reference 40, and an overlaid grid. The map scale is 1 inch is equal to 100 feet and the grid scale is 1 box is equal to 625 square feet. Using the overlay, the area of contaminated soil occupied 632 boxes. Six hundred thirty-two boxes multiplied by 625 square feet per box is equal to 395,000 square feet [31; 40, Fig. 2].

This source does not include the area of the holding basin (source 1), the cooling water recharge pond (source 2), the sphagnum bog, the on-property buildings, or the paved areas [31; 40, Fig. 2].

Area of source (ft²): 395,000

Reference(s): [31; 40, Fig. 2]

The area of the "contaminated soil" source, in square feet, is divided by 34,000 to assign an Area Assigned Value to the source [1, p. 51591, Tab. 2-5].

395,000 square feet ÷ 34,000 = 11.62

Area Assigned Value: 11.62

2.4.2.1.5. Source Hazardous Waste Quantity Value

The Hazardous Waste Quantity was calculated based on the Area Assigned Value of Source No. 3. The Hazardous Constituent Quantity, Hazardous Wastestream Quantity, and Volume Assigned Values were not scored for Source No. 3 because insufficient information was available [1, p. 51591].

Source Hazardous Waste Quantity Value: 11.62

SITE SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value	Containment			
		Ground Water	Surface Water	Gas	Air Particulate
1	1,018.46	10	10	NS	NS
2	2,403.85	10	10	NS	NS
3	11.62	10	10	NS	NS

[1, pp. 51596, 51609, Tab. 3-2, Tab. 4-1]

NS = Not scored

Total Source Hazardous Waste Quantity Value = 3,434

3.0 GROUND WATER MIGRATION PATHWAY

On March 20, 1980, the Massachusetts Department of Environmental Quality Engineering (MADEQE) collected a ground water sample from a Nuclear Metals, Inc. process/drinking water well (SW-2A). The ground water sample was analyzed for VOCs on March 25, 1980. Original laboratory analytical documents from this sampling event were not available in file information [81]. According to a MADEQE summary data table, laboratory analysis detected eight VOCs in this ground water sample [47]. Approximately 350 people worked at the NMI facility in March 1980 [81]. Therefore, well SW-2A provided VOC-contaminated drinking water to 350 employees of NMI between the sample collection date and the laboratory analysis date (for at least 5 days). After March 25, 1980, this well was reportedly only used to obtain process water [48]. However, for the purposes of this HRS package, the 350 people who obtained drinking water from the contaminated well for at least 5 days were not considered targets due to the lack of original analytical documentation.

3.0.1 GENERAL CONSIDERATIONS

Ground water flows through two distinct units, overburden and bedrock [67, Tab. 3]. Copper, uranium, ²²⁸thorium, ²³⁰thorium, and ²³²thorium, which are associated with the NMI site, have been identified in ground water from both the overburden and bedrock aquifers [40, Fig. 2; 53, p. 6; 55, pp. 10, 28, 30, 32; 67, Tab. 1]. Therefore, for the purpose of this HRS package, these two aquifers are considered to be interconnected.

Aquifer/Stratum 1 (shallowest)

Aquifer/Stratum Name: Overburden aquifer unit

Description:

NMI is underlain by thick deposits of sand and gravel which constitute significant ground water supply resources [49, p. 13]. The materials encountered during on-site explorations consist of stratified glacial soils, which overlie glacial till and bedrock [49, p. 14]. GZA reported that water enters the aquifer from both natural (precipitation) and artificial (cooling water recharge pond, holding basin, and septic systems) sources on site [49, p. 19].

Well sorted glacial deposits of gravel, sand, and silt have been identified in Concord, Massachusetts. These deposits filled bedrock valleys and are typically 30 to 70 feet thick [45, p. 3-1]. The deposit thickens to the north of the property and exceeds 100 feet in the vicinity of the Assabet River [49, p. 16].

The aquifers in Concord, Massachusetts are predominantly unconfined and semi-confined. Sand and gravel units typically extend from ground surface to the base of the overburden aquifer with intermittent clay layers and lenses [45, p. 3-2]. The lacustrine silt and clays that make up the semi-confined layers are less than 10 feet thick [34].

Transmissivity in the overburden aquifer ranges from 1,350 to 4,000 feet per day (100 to 300 gallons per minute) in the vicinity of the holding basin, cooling water recharge pond, and sphagnum bog. South and west of the holding basin, transmissivity in the aquifer occurs at less than 1,350 feet per day (less than 100 gallons per minute) [36].

References: [34; 36; 45, pp. 3-1, 3-2; 49, pp. 13, 19]

Aquifer/Stratum 2 (deepest)

Aquifer/Stratum Name: Bedrock aquifer unit

Description:

Bedrock beneath the NMI property has been mapped as "OZnb". "OZnb" bedrock refers to Nashoba Formation (Ordovician or Proterozoic C), Boxford member, thin bedded to massive amphibolite, minor biotite gneiss [32; 38].

Bedrock to the northwest of the NMI property has been mapped as "OZn". "OZn" bedrock refers to Silimanite schist and gneiss, partly sulfidic, amphibolite, biotite gneiss, calc-silicate gneiss and marble [32; 38].

Bedrock to the southeast of the NMI property has been mapped as "OZf". "OZf" bedrock refers to Nashoba Formation (Ordovician or Proterozoic C), Fish Brook gneiss, light gray biotite-plagioclase quartz gneiss, with a distinctive 'swirl form' foliation [32; 38].

The materials during on-site explorations consist of stratified glacial soils, which overlie glacial till and bedrock [49, p. 14]. Bedrock elevations decrease toward the Assabet River, which flows over or near a buried pre-glacial stream valley [49, p. 15].

Bedrock is not exposed at the ground surface on the NMI property [77, p. 4]. Bedrock depths beneath the property range from 45.5 feet to 109 feet [67, Tab. 1]. NMI's bedrock well (SW-2A) was constructed with 8-inch casing to 103 feet and is an open hole from 103 to 537 feet [67, Tab. 1]. This well draws water from permeable fracture zones or rock unit contacts [49, p. 14]. The open contacts and fracture zones serve as conduits, receiving water from storage in the overlying soil deposits and transmitting it through the bedrock [49, p. 14]. GZA reported that sampling results from September 29, 1980, indicated these open contacts and fracture zones transport contaminated ground water or surface water [49, p. 15]. GZA reported that water enters the aquifer from both natural (precipitation) and artificial (cooling water recharge pond, holding basin, and septic systems) sources on site [49, p. 19].

References: [32; 38; 49, pp. 14-15, 19; 77, p. 4]

3.1 LIKELIHOOD OF RELEASE

3.1.1 OBSERVED RELEASE

Aquifer Being Evaluated: Bedrock and Overburden Aquifer

Chemical Analysis:

- Background Concentration

Extensive ground water sampling of monitoring wells on and off property has been performed by GZA since 1988. Ground water analytical results indicate contamination from VOCs, metals, and radionuclides in wells screened in both overburden and bedrock. For the purpose of the HRS package, these aquifers are considered to be one interconnected aquifer. Copper, uranium, ²²⁸thorium, ²³⁰thorium, and ²³²thorium, which are associated with the NMI facility, have been detected in both the overburden and bedrock aquifer [53, p. 6; 55, pp. 10, 28, 30, 32].

The NMI property is located in a mixed residential area. To the north is Main Street with commercial and residential properties, and the Assabet River. To the east are woodland and residential properties. To the west are woodland and commercial/industrial properties. To the south are woodland and residential properties [3; 40, p. 3, Fig. 2]. No alternative anthropogenic sources of the above listed hazardous substances in ground water have been identified.

Monitoring well GZW-5 was installed by GZA in 1983. GZW-5 is constructed of 1.5 inch diameter polyvinyl chloride; screened from 40 to 55 feet; and its soil boring was advanced to a total depth of 58 feet [67, Tab. 1]. Soil material in the boring consisted of very dense silt from 0 to 52 feet, and dense fine to coarse silty sand and gravel from 52 to 58 feet [67, App. D].

GZA determined that ground water flows toward the Assabet River under both pumping and non-pumping conditions of SW-1 and/or SW-2A [77, p. 4]. The rationale for the selection of GZW-5 as a background monitoring well follows:

- it is located upslope and hydrologically upgradient of the on-site sources
- it is within the same overburden/bedrock interconnected aquifer
- it is not in an area of known contamination [3; 31; 40, Tab. 1, Fig. 2].

The ground water samples listed below, chosen to represent background conditions, were collected between October 1993 and April 1998. The location of GZW-5, on the southeastern portion of the Nuclear Metals Inc. site, is shown on Figure 5.

Sample ID	Screened Interval (feet)	Date	Reference
GZW-5	40-55	April 29, 1998	[55, pp. 23-25; 67, Tab. 1]
GZW-5	40-55	October 28, 1997	[55, pp. 14-16, 32; 67, Tab. 1]
GZW-5	40-55	May 15, 1997	[54, pp. 15-17; 67, Tab. 1]
GZW-5	40-55	October 24, 1996	[54, pp. 7-9; 67, Tab. 1]
GZW-5	40-55	October 19, 1995	[53, pp. 3-5, 7; 67, Tab. 1]
GZW-5	40-55	May 4, 1994	[56, p. 3; 67, Tab. 1]
GZW-5	40-55	October 27, 1993	[56, p. 1; 67, Tab. 1]

Sample ID	Hazardous Substance	Concentration (ppb)	Sample Quant. Limit (ppb)	Date	Reference
GZW-5	acetone	ND	25	10/24/96	[54, p. 7]
GZW-5	benzene	ND	5	5/4/94	[56, p. 3]
GZW-5	C. disulfide	ND	2	10/24/96	[54, p. 7]
GZW-5	1,1-DCA	ND	1	4/29/98	[55, p. 24]
GZW-5	1,1-DCE	ND	1	4/29/98	[55, p. 24]
GZW-5	cis-1,2-DCE	ND	1	4/29/98	[55, p. 24]
GZW-5	naphthalene	ND	1	10/24/96	[54, p. 9]
GZW-5	PCE	ND	1	4/29/98	[55, p. 24]
GZW-5	1,1,1-TCA	ND	1	4/29/98	[55, p. 24]
GZW-5	TCE	ND	1	4/29/98	[55, p. 24]
GZW-5	toluene	ND	1	10/19/95	[53, p. 3]
GZW-5	vinyl chloride	ND	2	10/24/96	[54, p. 7]
GZW-5	beryllium	ND	0.002 †	10/28/97	[55, p. 16, Tab. 7]
GZW-5	copper	0.022 †	0.012 †	10/28/97	[55, p. 16, Tab. 11]
GZW-5	iron	0.02 †	0.007 †	10/28/97	[55, p. 16, Tab. 12]
GZW-5	manganese	0.005 †	0.003 †	4/29/98	[55, p. 25, Tab. 13]
GZW-5	molybdenum	ND	0.02 †	10/27/93	[56, p. 1; 92]
GZW-5	uranium	0.092±0.018	0.017	10/28/97	[11; 55, p. 32]
GZW-5	²²⁸ thorium	0.062±0.185 †	0.351 ◇	10/19/95	[53, p. 7; 92]
GZW-5	²³⁰ thorium	0.324±0.156 †	0.148 ◇	10/19/95	[53, p. 7; 92]
GZW-5	²³² thorium	0.015±0.031 †	0.118 ◇	10/19/95	[53, p. 7; 92]

† = units are in pCi/L (picoCuries per Liter)

◇ = units are in ppm (parts per million)

3) = MDA = minimum detectable activity

ND = not detected. The chemical was analyzed for and was not detected.

ppb = parts per billion

TCA = trichloroethane

TCE = trichloroethene

PCE = tetrachloroethene

DCA = dichloroethane

DCE = dichloroethene

C. disulfide = carbon disulfide

Quant. = Quantitation

- Contaminated Samples

In 1988, GZA began installing and sampling monitoring wells on and off the NMI property. GZA has collected ground water samples from the NMI property since 1988 as part of a long-term ground water monitoring effort. Available information consists of summary reports, laboratory analytical data sheets, and quality assurance/quality control information related to the ground water sampling events. Ground water analytical results from 1988 through 1993 are consistent with data from later reporting years and serve to establish the documentation of a long-term ground water contamination issue [53-56].

Sample ID	Screened Interval (feet)	Date	Reference
OW-1	19-29	5/4/98	[55, pp. 26-27; 67, Tab. 1]
SW-2A	* 103-537 (OH)	4/28/98	[55, pp. 20-22; 67, Tab. 1]
HBPZ-2	42.1-52.1	10/28/97	[55, p. 32; 65, App. D]
MW-1	23-38	10/28/97	[55, pp. 17-19; 67, Tab. 1]
GZW6-3	* 112.5-114	10/23/97	[55, p. 30; 67, Tab. 1]
GZW-11-2	* 155-175	10/23/97	[55, pp. 9-10; 65, App. C]
P-1	48-53	10/23/97	[55, pp. 4-6; 67, Tab. 1]
PW-8 **	56	10/23/97	[55, pp. 11-13; 67, Tab. 1]
GZW-10-2	* 142-152	10/23/97	[55, pp. 7-9; 65, App. C]
MW-2	13.6-23.6	10/22/97	[55, pp. 1-3; 67, Tab. 1]
SW-2A	* 103-537 (OH)	10/22/97	[55, p. 28; 67, Tab. 1]
WP-2	???	5/15/97	[54, pp. 10-11; 65, App. C]
PW-8 **	56	10/23/96	[54, pp. 4-6; 67, Tab. 1]
ML-3-1	* 25-30	10/22/96	[54, pp. 1-3; 67, Tab. 1]
ML-1-3	* 80-81.5	10/18/95	[53, p. 6; 67, Tab. 1]
ML-3-3	* 52-53.5	10/18/95	[53, p. 1; 67, Tab. 1]
ML-3-1	* 25-30	10/18/95	[53, p. 6; 67, Tab. 1]
HB-10	49-64	10/14/95	[53, p. 6; 67, Tab. 1]
GZW-6-3	* 112.5-114	5/11/94	[56, pp. 5-6; 67, Tab. 1]
HB-8	61-76	10/27/93	[56, p. 2; 67, Tab. 1]

* = indicates a bedrock well

** = screened interval information not reported; number represents well depth

OH = open hole interval

??? = well log was not present in available information

For each sample, a chemical is listed if it is detected at least three times greater than the reference sample concentration. However, if the chemical is not detected in the reference sample, the reference sample's sample quantitation limit is used as the reference value. These chemicals are listed if they were detected at a concentration greater than or equal to the reference sample's sample quantitation limit. The data presented below include the highest concentrations of substances in both bedrock and overburden monitoring wells for the October 1993 to May 1998 reporting period. Refer to Figure 5 for monitoring well locations.

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

Sample ID	Hazardous Substance	Conc. (ppb)	Sample Quant. Limit (ppb)	Date	Reference
WP-2	acetone	28	25	5/15/97	[54, p. 10; 83]
GZW-6-3	benzene	5.4	5	5/11/94	[56, p. 5]
PW-8	C. disulfide	5.5	2	10/23/96	[54, p. 4; 83]
GZW-10-2	1,1-DCA	7.3	1	10/23/97	[55, p. 7; 83]
MW-1	1,1-DCE	39	5	10/28/97	[55, p. 17; 83]
PW-8	cis-1,2-DCE	2.8	1	10/23/97	[55, p. 12; 83; 84]
ML-3-1	naphthalene	7.8	1	10/22/96	[54, p. 3; 83; 84]
OW-1	PCE	6.9	1	5/4/98	[55, p. 27; 83]
OW-1	1,1,1-TCA	170	1	5/4/98	[55, p. 26; 83]
OW-1	TCE	350	1	5/4/98	[55, p. 26; 83]
ML-3-3	toluene	2.3	1	10/18/95	[53, p. 1; 83]
WP-2	v.chloride	2.7	2	5/15/97	[54, p. 10; 83]
P-1	beryllium	0.003	‡ 0.002 ‡	10/23/97	[55, p. 6, Tab. 7]
GZW-11-2	copper	0.242	‡ 0.012 ‡	10/23/97	[55, p. 10, Tab. 11]
MW-2	iron	0.318	‡ 0.007 ‡	10/22/97	[55, p. 3, Tab. 12]
SW-2A	manganese	0.084	‡ 0.005 ‡	4/28/98	[55, p. 22, Tab. 13]
HB-8	molybdenum	0.025	‡ 0.02 ‡	10/27/93	[56, p. 2]
HBPZ-2	uranium	2,280±390	17	10/28/97	[11; 55, p. 32]
GZW-6-3	uranium	31.5±5.1	0.17	10/23/97	[11; 55, p. 30]
SW-2A	uranium	25.7±4.2	0.16	10/22/97	[11; 55, p. 28]
HB-10	²³² thorium	0.432±0.107†	0.05 ◇	10/19/95	[53, p. 7]
ML-1-3	²²⁸ thorium	3.45±0.3 †	0.09 ◇	10/18/95	[53, p. 6]
ML-1-3	²³⁰ thorium	2.83±0.263 †	0.058 ◇	10/18/95	[53, p. 6]
ML-1-3	²³² thorium	3±0.266 †	0.036 ◇	10/18/95	[53, p. 6]
ML-3-3	²³² thorium	0.572±0.106†	0.045 ◇	10/18/95	[53, p. 6]
ML-3-1	²³² thorium	0.385±0.089†	0.048 ◇	10/18/95	[53, p. 6]

† = units are in pCi/L (picoCuries per Liter)

◇ = units are in ppm (parts per million)

■ = MDA = minimum detectable activity

ppb = parts per billion

TCA = trichloroethane

TCE = trichloroethene

PCE = tetrachloroethene

DCA = dichloroethane

DCE = dichloroethene

C. disulfide = carbon disulfide

Conc. = Concentration

Quant. = Quantitation

v. chloride = vinyl chloride

Attribution:

In 1958, NMI began operating a manufacturing facility on previously undeveloped land [50, p. 4]. They produced depleted uranium products, primarily as penetrators for armor piercing ammunition. NMI also manufactured metal powders for medical applications, photocopiers, and specialty metal products, such as beryllium tubing used in the aerospace industry [42, pp. 2, 21].

From 1958 to 1985, NMI discharged process wastes to an unlined holding basin (source 1) [43, p. 1-6].

Analytical results of source samples document the presence of copper, uranium, and ²³⁰thorium in Source 1 (unlined holding basin); naphthalene, copper, and uranium in Source 2 (unlined cooling water recharge pond); and beryllium, copper, molybdenum, and uranium in Source 3 (area of contaminated soil) [60; 61; 63]. Additionally,

chemicals used during operational processes and associated with source 1 (unlined holding basin) include acetone, 1,1,1-trichloroethane, and beryllium [50, pp. 9-10; 61]. Hazardous substances detected in ground water supply wells SW-1 and SW-2A used for the non-contact cooling water and associated with source 2 (unlined cooling water recharge pond) include tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, iron, and manganese [54; 55; 60].

²²⁸Thorium and ²³²thorium are known to be ²³²uranium and ²³⁶uranium radioactive decay products. Uranium has been documented on site [85-87].

The property is located in a mixed residential area. To the north is Main Street with commercial and residential properties, and the Assabet River. To the east are woodland and residential properties. To the west are woodland and commercial/industrial properties. To the south are woodland and residential properties [3; 40, p. 3, Fig. 2]. No alternative anthropogenic sources of the above listed hazardous substances in ground water have been identified.

Hazardous Substances Released

Based on chemical analysis of soil and/or sediment samples from source 1 (holding basin), source 2 (cooling water recharge pond), source 3 (area of contaminated soil), and based on documented past operational processes, the following substances meet the criteria for an observed release to ground water: acetone; benzene; carbon disulfide; 1,1-DCA; 1,1-DCE; cis-1,2-DCE; naphthalene; PCE; 1,1,1-TCA; TCE; toluene; vinyl chloride; beryllium; copper; iron; manganese; molybdenum; uranium; ²²⁸thorium; ²³⁰thorium; and ²³²thorium.

=====

Ground Water Observed Release Factor Value: 550

3.2 WASTE CHARACTERISTICS

3.2.1 Toxicity/Mobility

Hazardous Substance	Source No.	Toxicity Factor Value	Mobility Factor Value	Toxicity/ Mobility	Reference
acetone	1	10	1	10	[2, p. B-1]
anthracene	2	10	0.01	0.1	[2, p. B-2]
BAA	2,3	1,000	0.01	10	[2, p. B-2]
BAP	2,3	10,000	0.0001	1	[2, p. B-3]
BBF	2,3	1,000	0.0001	0.1	[2, p. B-3]
benzene	■	100	1	100	[2, p. B-2]
BGHIP	2,3	NL	0.0001	<>	[2, p. B-3]
BKF	2,3	100	0.0001	0.01	[2, p. B-3]
C. disulfide	■	10	1	10	[2, p. B-4]
chrysene	2,3	10	0.01	0.1	[2, p. B-5]
cis-1,2-DCE	■	100	1	100	[2, p. B-8]
1,1-DCA	■	10	1	10	[2, p. B-7]
1,1-DCE	■	100	1	100	[2, p. B-7]
fluoranthene	2,3	100	0.01	1	[2, p. B-10]
HCl	1	100	1	100	[2, p. B-12]
IP	2,3	1,000	0.0001	0.1	[2, p. B-12]
naphthalene	2	100	1	100	[2, p. B-14]
nitric acid	1	10	1	10	[2, p. B-14]
PCE	2	100	1	100	[2, p. B-18]
phenanthrene	2,3	NL	0.01	<>	[2, p. B-16]
pyrene	2,3	100	0.01	1	[2, p. B-17]
sulfuric acid	1	1,000	1	1,000	[2, p. B-18]
1,1,1-TCA	1,2	1	1	1	[2, p. B-19]
TCE	2	10	1	10	[2, p. B-19]
toluene	■	10	1	10	[2, p. B-19]
vinyl chloride	■	10,000	1	10,000	[2, p. B-20]
arsenic	1,3	10,000	0.01	100	[2, p. B-2]
beryllium	1,3	10,000	1	10,000	[2, p. B-3]
calcium	1	NL	1	<>	[2, p. B-4]
copper	1,2,3	NL	1	<>	[2, p. B-6]
iron	2	1	1	1	[2, p. B-12]
magnesium	1,3	NL	1	<>	[2, p. B-13]
manganese	2	10,000	1	10,000	[2, p. B-13]
molybdenum	3	100	1	100	[2, p. B-14]
thorium	1	NL	NL	<>	[2]
uranium	1,2,3	NL	NL	<>	[2]

Hazardous Substance	Source No.	Toxicity Factor Value	Mobility Factor Value	Toxicity/ Mobility	Reference
²¹⁰ lead	1	10,000	0.01	100	[2, p. B-85]
²²⁶ radium	1	10,000	0.01	100	[2, p. B-86]
²²⁸ thorium	■	10,000	1	10,000	[2, p. B-86]
²³⁰ thorium	1	10,000	1	10,000	[2, p. B-86]
²³² thorium	■	10,000	1	10,000	[2, p. B-87]
²³⁵ uranium	1,3	10,000	0.01	100	[2, p. B-87]
²³⁸ uranium	3	10,000	0.01	100	[2, p. B-87]

NL = factor value not listed in SCDM
 <> = not calculated because factor value is not listed in SCDM.
 TCA = trichloroethane
 TCE = trichloroethene
 PCE = tetrachloroethene
 DCA = dichloroethane
 DCE = dichloroethene
 HCl = hydrochloric acid
 BAA = benzo(a)anthracene
 BAP = benzo(a)pyrene
 BBF = benzo(b)fluoranthene
 BGHIF = benzo(ghi)perylene
 BKF = benzo(k)fluoranthene
 IP = indeno(123-cd)pyrene
 C. disulfide = carbon disulfide
 1 = source 1 = holding basin
 2 = source 2 = cooling water recharge pond
 3 = source 3 = contaminated soil
 † = Either these substances were not analyzed in a source sample or are known to be at the site but can not be associated with a specific source. Carbon disulfide, 1,1-DCA, and toluene have been identified in liquid collected from an on-site septic system [69-76; 88, p. 11]. Benzene, 1,1-DCE, cis-1,2-DCE, and vinyl chloride were detected in monitoring wells other than the background ground water well [53, pp. 3, 7; 54, pp. 7, 9; 55, pp. 16, 24, 25, 32; 56, pp. 1, 3]. ²²⁸Thorium and ²³²thorium are known to be ²³²uranium and ²³⁶uranium radioactive decay products. Uranium has been documented on site. The thorium isotopes have been included as hazardous substances [85-87].

The highest toxicity/mobility value is 10,000 for vinyl chloride, beryllium, manganese, ²²⁸thorium, ²³⁰thorium, and ²³²thorium.

=====Toxicity/Mobility Factor Value: 10,000=====

3.2.2 Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5)	Is source hazardous constituent quantity data complete? (yes/no)
1	1,018.46	no
2	2,403.85	no
3	11.62	no

Sum of Values: 3,434

The resulting Hazardous Waste Quantity Factor Value of 100 is determined from Table 2-6 [1, p. 51591] for the ground water migration pathway.

3.2.3 Waste Characteristics Factor Category Value

Of the hazardous substances documented at Nuclear Metals Inc., vinyl chloride, beryllium, manganese, ²²⁸thorium, ²³⁰thorium, and ²³²thorium have the highest toxicity/mobility: 10,000. This product multiplied by the Waste Quantity Factor Value of 100 results in a value of 1E+06. The waste characteristic factor category value determined from Table 2-7 is 32 [1, p. 51592].

Toxicity/Mobility Factor Value

x Hazardous Waste Quantity Factor Value: = 10,000 x 100 = 1E+06

=====

Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 32

3.3 TARGETS

The following public/community well identification numbers were obtained from MADEP's Active Massachusetts Water Systems and their Sources and accompanying Bureau of Waste Site Cleanup (BWSC) Water Resource Maps [37].

Well	Distance From Source (miles)	Aquifer	Level I Contam. (Y/N)	Level II Contam. (Y/N)	Potential Contam. (Y/N)	Reference @
3067015-01G	0.06	1, 2	N	N	Y	[17; 37, p. 8]
2002000-05G	0.30	1, 2	N	N	Y	[14; 37, p. 1]
2002000-06G	0.30	1, 2	N	N	Y	[14; 37, p. 1]
3067000-05G	0.30	1, 2	N	N	Y	[16; 37, p. 8]
2002000-03G	1.15	1, 2	N	N	Y	[14; 37, p. 1]
3067000-01G	1.15	1, 2	N	N	Y	[16; 37, p. 8]
2002000-08G	1.15	1, 2	N	N	Y	[14; 37, p. 1]
2002000-04G	1.45	1, 2	N	N	Y	[14; 37, p. 1]
2174000-02G	1.80	1, 2	N	N	Y	[20; 37, p. 14]
2174000-03G	1.80	1, 2	N	N	Y	[20; 37, p. 14]
2174000-01G	1.80	1, 2	N	N	Y	[20; 37, p. 13]
3067000-04G	1.95	1, 2	N	N	Y	[16; 37, p. 8]
3067000-03G	2.15	1, 2	N	N	Y	[16; 37, p. 8]
2174000-04G	2.45	1, 2	N	N	Y	[20; 37, p. 14]
2286010-01G	3.10	1, 2	N	N	Y	[21; 37, p. 15]
2286004-01G	3.15	1, 2	N	N	Y	[23; 37, p. 15]
2286003-01G	3.20	1, 2	N	N	Y	[23; 37, p. 15]
2002010-01G	3.20	1, 2	N	N	Y	[15; 37, p. 2]
3157000-02G	3.35	1, 2	N	N	Y	[18; 37, p. 9]
2002014-02G	3.35	1, 2	N	N	Y	[26; 37, p. 2]
2002014-01G	3.35	1, 2	N	N	Y	[26; 37, p. 2]
2002000-02G	3.70	1, 2	N	N	Y	[14; 37, p. 1]
3067000-02G	3.80	1, 2	N	N	Y	[16; 37, p. 8]
3288000-03G	3.80	1, 2	N	N	Y	[19; 37, p. 10]
3288000-08G	3.80	1, 2	N	N	Y	[19; 37, p. 11]

@ = Additional reference [3; 4; 5]

1 = overburden aquifer

2 = bedrock aquifer

Note: For the purpose of this HRS package, the overburden and bedrock aquifers are considered interconnected; the interconnected unit is designated 1,2.

3.3.1 Nearest Well

The Town of Concord does not maintain records on private well users [34].

Well: Valley Sports Inc. (non-community)
3067003-01G
Active

Reference: [17; 37, p. 8]

Level of Contamination (I, II, or potential): Potential

If potential contamination, distance from source in miles: 0.06 of a mile from Source No. 3.

Reference: [3]

A distance between 0 and 0.25 of a mile is assigned a nearest well factor value of 20 [1, p. 51603, Tab. 3-11].

=====

Nearest Well Factor Value: 20

3.3.2 Population

No Level I ground water actual contamination targets have been identified or sufficiently documented to date.

3.3.2.1 Level of Contamination

3.3.2.2 Level I Concentrations

<u>Level I Well</u>	<u>Population</u>	<u>Reference</u>
Not scored		

=====

Population Served by
Level I Wells:

Level I Concentrations Factor Value: 0

3.3.2.3 Level II Concentrations

No Level II ground water actual contamination targets have been identified or sufficiently documented to date.

Level II Well	Population	Reference
---------------	------------	-----------

Not scored		
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=====

Level II Concentrations Factor Value: 0

3.3.2.4 Potential Contamination

Distance Category (miles)	Pop.	Reference	Distance-Weighted Population Value
0.00 to 0.25	25	[3-5; 13; 17; 37, p. 8]	17
> 0.25 to 0.50	5,226	[3-5; 13; 14; 16; 37, pp. 1, 8]	3,233
> 0.5 to 1.00	74	[3-5; 13]	17
> 1.00 to 2.00	15,646	[3-5; 13; 14; 16; 20; 37, pp. 1, 8, 13, 14]	2,939
> 2.00 to 3.00	5,576	[3-5; 13; 16; 20; 37, pp. 8, 14]	678
> 3.00 to 4.00	11,159	[3-5; 13-16; 18; 19; 21; 23; 26; @]	1,306

Sum of Distance-Weighted Population Values: 8,190

Pop. = Population

@ = Additional reference [37, pp. 1, 2, 8, 9, 10, 11, 15]

Note: Reference 13 is refers to: [13, pp. 9, 10]

A Sum of Distance-Weighted Population Value is divided by 10 to determine the Potential Contamination Factor Value [1, p. 51604].

Total distance weighted factor divided by 10: 8,190 / 10 = 819

=====

Potential Contamination Factor Value: 819

3.3.3 RESOURCES

Water drawn from a target well in the aquifer being evaluated is used for one or more of the following purposes: irrigation (5-acre minimum) of commercial food crops or commercial forage crops; or supply for a major or designated water recreation area, excluding drinking water use [14; 16; 25].

The following public/community well identification numbers were obtained from MADEP's Active Massachusetts Water Systems and their Sources and accompanying BWSC Water Resource Maps [37].

Well	Aquifer	Resource Use	Reference
3067000-01G	1,2	□	[16; 37, p. 8]
3067000-02G	1,2	□	[16; 37, p. 8]
3067000-03G	1,2	□	[16; 37, p. 8]
3067000-04G	1,2	□	[16; 37, p. 8]
3067000-05G	1,2	□	[16; 37, p. 8]
2002000-02G	1,2	□, ○	[14; 25; 37, p. 1]
2002000-03G	1,2	□, ○	[14; 25; 37, p. 1]
2002000-04G	1,2	□, ○	[14; 25; 37, p. 1]
2002000-05G	1,2	□, ○	[14; 25; 37, p. 1]
2002000-06G	1,2	□, ○	[14; 25; 37, p. 1]
2002000-08G	1,2	□, ○	[14; 25; 37, p. 1]

-
- † = supply for a major or designated water recreation area, excluding drinking water use
 - ◇ = irrigation (5-acre minimum) of commercial food crops or commercial forage crops
 - 1 = overburden aquifer
 - 2 = bedrock aquifer

Note: For the purpose of this HRS package, the overburden and bedrock aquifers are considered interconnected; the interconnected unit is designated 1,2.

=====

Resources Factor Value: 5

3.3.4 WELLHEAD PROTECTION AREA

A Zone II wellhead protection area surrounds Concord's public ground water supply well 3067000-05G [37, p. 8; 44]. The cooling water recharge pond and the holding basin are located entirely within Zone II of this public ground water supply well. The southern extent of the contaminated soil source is also located entirely within Zone II of this public ground water supply well [44]. A source with a ground water containment value greater than 0 lies within or above the designated wellhead protection area 3; 35; 40, p.4; 42, pp 3-4; 43, p. 3-1; 50, pp. 4, 7]. Observed ground water contamination attributable to the sources at the site lies within the designated wellhead protection area; therefore, a wellhead protection area factor value of 20 is assigned [1, p. 51604].

Area	Use	Reference	Value
3067000-05G	Zone II	[37; 44]	20

=====Wellhead Protection Area Factor Value: 20
SWOF-Surface Water Overland Flow/Flood Migration Pathway

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

The Assabet River is located approximately 400 feet north and downslope of the NMI property [3]. The Town of Concord does not maintain records for catch basin connections [34]. According to GZA, contractor for Starmet, ground water flow beneath the property is generally to the north and northwest, toward the Assabet River [40, p. 6]. However, for the purposes of this HRS package, the Assabet River has not been scored for the overland flow or ground water to surface water migration because the sphagnum bog watershed yielded a higher surface water pathway score.

4.1.1.1 DEFINITION OF HAZARDOUS SUBSTANCE MIGRATION PATH FOR OVERLAND/FLOOD COMPONENT

From 1958 to 1985, NMI discharged process waste to the holding basin [42, p. 3; 43, p. 1-6]. They discharged the supernatant from the waste to the sphagnum bog; however, this practice was discontinued after a "brief use" [51, p. 19]. Available information does not indicate the period of time that the supernatant was discharged to the sphagnum bog.

The sphagnum bog is located within approximately 100 feet of Source 1, Source 2, and Source 3 [3; 40, Fig. 2]. The surface and subsurface substrate of the bog is sphagnum peat in varying stages of decay [65, p. 11]. No tributaries or streams to the Assabet River are located on the NMI property. The sphagnum bog has no inlet or outlet [67, p. 40]. Precipitation, which does not infiltrate the ground surface, flows overland and enters the sphagnum bog, based on property topography [3]. Overland flow originates on the NMI site in the vicinity of Source 1, Source 2, and Source 3. The probable point of entry of overland flow into the sphagnum bog, an isolated wetland, would occur at the two former holding basin discharge pipes located along the southwestern edge of the sphagnum bog [3; 65, Fig. 3].

No surface water drinking water intakes are located within the sphagnum bog [3; 22]. Water quality for the sphagnum bog has not been designated by MADEP. According to MADEP, the sphagnum bog is not utilized as a fishery [81].

The flow rate of the sphagnum bog (0.27 cubic feet per second) was estimated using:

- the US Geological Survey (USGS) mean annual runoff rate for New England (22 inches per year), converted to 1.62 cubic feet per second per square mile; and
- the drainage area of the sphagnum bog (0.0024 square miles) [3; 33].

Approximately 0.36 of a mile of wetland frontage occurs along the downstream surface water pathway. No endangered or threatened species occur along the downstream surface water pathway [3; 12; 33]. Refer to Figure 6 for surface water and sediment sampling locations.

4.1.2.1 LIKELIHOOD OF RELEASE

4.1.2.1.1 Observed Release

In May 1996, GZA collected sediment samples from several locations in the sphagnum bog. Sediment sample analytical results document an observed release of toluene, copper, manganese, ²²⁸thorium, ²³⁰thorium, ²³²thorium, and uranium [40, Fig. 2; 58, pp. 1-22; 65, Fig. 3].

In June 1996, GZA collected surface water samples from several locations in the sphagnum bog. Surface water sample analytical results document an observed release of calcium, copper, magnesium, and uranium [40, Fig. 2; 57, pp. 1-18; 77, Fig. 2A].

From 1958 to 1985, NMI discharged process waste to the holding basin. They discharged the supernatant from the waste to the sphagnum bog; however, this practice was discontinued after a "brief use" [51, p. 19].

From 1958 to 1985, NMI discharged wastes to an unlined holding basin. Cast depleted uranium ingots or billets were jacketed, sealed, and evacuated in copper cans, which were then heated and extruded into long rod stock. The extruded depleted uranium rod had a resulting thin layer of copper coating which was removed in a nitric acid pickling operation. During the pickling process, "small quantities" of copper and uranium were dissolved in the nitric acid. The spent nitric acid solution was collected, neutralized with a lime slurry, and then discharged to the unlined, in-ground holding basin. "Small quantities" of other specialty metal products including steel jacketed beryllium, stainless steel, and titanium alloys were also pickled at various times with several different acids (nitric, hydrofluoric, hydrochloric, and sulfuric), and discharged to the holding basin [43, p. 1-6].

In addition to natural and depleted uranium (as elemental, oxide, and fluoride), NMI handled thorium and thorium oxide under license to the NRC; sulfuric and nitric acids for process activities; 1,1,1-trichloroethane as a solvent; trichlorofluoroethane as a degreaser; zirconium; magnesium; beryllium; acetone; hydrogen peroxide; flammable gases (propane and acetylene); and oxygen [66, p. 5].

On October 1, 1997, Nuclear Metals, Inc. was renamed Starmet Corporation [79]. In March 1997, the company's license to handle source material (including depleted uranium, thorium, and thorium oxide) under the NRC was transferred to the Massachusetts Department of Public Health [9]. In accordance with Massachusetts state license SM-0179, Starmet is allowed to use source material (including depleted uranium, thorium, and thorium oxide) to manufacture, research, develop, and distribute metallic products in a variety of forms including castings, extensions, and metal powders [9].

Direct Observation

- Basis for Direct Observation

The supernatant from metal hydroxide sludge was discharged from the holding basin directly to the sphagnum bog for a "brief" time [51, p. 19].

- Hazardous Substances in the Release

From 1958 to 1985, NMI discharged wastes to an unlined holding basin [42, p. 3; 43, p. 1-6]. These wastes included the following: acetone; 1,1,1-trichloroethane; trichlorofluoroethane; beryllium; copper; depleted uranium; magnesium; stainless steel; thorium; thorium oxide; titanium alloys; zirconium; hydrochloric acid; hydrofluoric acid; hydrogen peroxide; nitric acid; and sulfuric acid [43, p. 1-6; 66, p. 5].

Chemical Analysis

- Background Concentration (surface water)

Surface water sample CBSW-9 was collected in the sphagnum bog, an isolated wetland, in June 1996 [57, pp. 6-7; 65, Fig. 3]. There is no upstream reference sample for the sphagnum bog [3; 40, Fig. 2; 8]. The probable point of entry into the sphagnum bog is located at the two former discharge pipes. Therefore, in relation to the former discharge pipes, surface water sample CBSW-9 was selected as the most geographically distant reference sample location. CBSW-9 was located on the eastern side of the sphagnum bog, approximately 400 feet northeast from discharge pipe No. 1 [40, Fig. 2; 65, Fig. 3].

The reference surface water sample was analyzed for copper by EPA Method 6010, magnesium and calcium by EPA Method 200, and uranium by ASTM Method D5174 [11; 65, pp. 4-5].

In July 1998, GZA collected surface water sample CBSW-104 from a location approximately 20 feet southwest of CBSW-9 [77, Tab. 3]. Concentrations of copper and uranium in CBSW-104 were similar to the concentrations collected from CBSW-9 in June 1996 and serve to establish a background reference area in the sphagnum bog due to lower concentrations of hazardous substances [65, Tab. 1; 77 Tab. 3]. Refer to Figure 6 for surface water sample locations.

Sample ID	Sampling Location	Depth	Date	Reference
CBSW-9	sphagnum bog	surface	June 12, 1996	[57, pp. 6-7]

One surface water sample (CBSW-9), collected on the eastern portion of the sphagnum bog, was selected to establish background concentrations for surface water sample locations CBSW-6, CBSW-7, CBSW-8, CBSW-10, CB-16AD CB-17AD, CB-18AD, CB-19AD, and CB-20AD [40, Fig. 2; 57, pp. 1-18; 65, Fig. 3].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CBSW-9	calcium	1 ppm	0.1 ppm	[57, p. 7]
CBSW-9	copper	ND	0.012 ppm	[57, p. 6; 83]
CBSW-9	magnesium	0.3 ppm	0.1 ppm	[57, p. 7]
CBSW-9	uranium	2.12± 0.305 ppb	0.056 ppb	[11; 57, p. 9]

ND = Not detected. The chemical was analyzed for and was not detected.

ppb = parts per billion

ppm = parts per million

- Contaminated Samples (surface water)

Surface water samples CBSW-6, CBSW-7, CBSW-8, CBSW-10, CB-16AD CB-17AD, CB-18AD, CB-19AD, and CB-20AD were collected by GZA in June 1996 [65, pp. 4-5, Tab. 2].

Surface water samples CBSW-6, CBSW-7, CBSW-8, and CBSW-10 were collected from the edges of the sphagnum bog where open water was present [65, Fig. 3]. Surface water samples CB-16AD, CB-17AD, CB-18AD, CB-19AD, and CB-20AD, were collected near or within a lag zone in the center of the sphagnum bog [65, Fig. 3]. These samples are considered similar in matrix and depth to the reference sample CBSW-9 [65, pp. 4-5, 13, Tab. 1].

The following surface water samples were analyzed for copper by EPA Method 6010, magnesium and calcium by EPA Method 200.7, and uranium by ASTM Method D5174 [11; 65, pp. 4-5]. Refer to Figure 6 for surface water sample locations.

Sample ID	Sampling Location	Depth	Date	Reference
CBSW-6	sphagnum bog	surface	June 12, 1996	[57, pp. 1-2, 9; @]
CBSW-7	sphagnum bog	surface	June 12, 1996	[57, pp. 3, 9; @]
CBSW-8	sphagnum bog	surface	June 12, 1996	[57, pp. 4-5, 9; @]
CBSW-10	sphagnum bog	surface	June 12, 1996	[57, pp. 8-9; @]
CB-16AD	sphagnum bog	surface	June 12, 1996	[57, pp. 10, 18; @]
CB-17AD	sphagnum bog	surface	June 12, 1996	[57, pp. 11-12, 18; @]
CB-18AD	sphagnum bog	surface	June 12, 1996	[57, pp. 13-14, 18; @]
CB-19AD	sphagnum bog	surface	June 12, 1996	[57, p. 15; @]
CB-20AD	sphagnum bog	surface	June 12, 1996	[57, p. 16; @]

@ = Additional reference [40, Fig. 2; 65, Fig. 3, Tab. 1, Tab. 2]

Laboratory analyses detected the following chemicals at concentrations greater than or equal to three times the reference sample concentration (CBSW-9) or greater than or equal to the sample quantitation limit: calcium, copper, magnesium, and uranium [57, pp. 1-18]

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CBSW-6	calcium	3.6 ppm	0.1 ppm	[57, p. 2]
CBSW-8	calcium	4.3 ppm	0.1 ppm	[57, p. 5]
CB-17AD	calcium	4.9 ppm	0.1 ppm	[57, p. 11]
CB-20AD	calcium	7 ppm	0.1 ppm	[57, p. 16]
CBSW-6	copper	0.075 ppm	0.012 ppm	[57, p. 1; 83]
CBSW-7	copper	0.122 ppm	0.012 ppm	[57, p. 3; 83]
CBSW-8	copper	0.092 ppm	0.012 ppm	[57, p. 4; 83]
CBSW-10	copper	0.027 ppm	0.012 ppm	[57, p. 8; 83]
CB-16AD	copper	0.036 ppm	0.012 ppm	[57, p. 10; 83]
CB-17AD	copper	0.117 ppm	0.012 ppm	[57, p. 12; 83]
CB-18AD	copper	0.14 ppm	0.012 ppm	[57, p. 13; 83]
CB-17AD	magnesium	1 ppm	0.1 ppm	[57, p. 11]
CB-18AD	magnesium	1.3 ppm	0.1 ppm	[57, p. 14]
CB-19AD	magnesium	0.9 ppm	0.1 ppm	[57, p. 15]
CB-20AD	magnesium	1.2 ppm	0.1 ppm	[57, p. 16]
CBSW-7	uranium	34.5±5.1 ppb	0.56 ppb	[11; 57, p. 9]
CB-18AD	uranium	31.5±4.65 ppb	0.56 ppb	[11; 57, p. 18]
CB-17AD	uranium	22.2±3.28 ppb	0.56 ppb	[11; 57, p. 18]
CBSW-6	uranium	21.3±3.15 ppb	0.56 ppb	[11; 57, p. 9]
CBSW-8	uranium	18.5±2.74 ppb	0.56 ppb	[11; 57, p. 9]

ppm = parts per million
ppb = parts per billion

Attribution:

From 1958 to 1985, NMI discharged process waste to the holding basin [42, p. 2; 43, p. 1-6]. They discharged the supernatant from the waste to the sphagnum bog; however, this practice was discontinued after a "brief use" [51, p. 19].

Analytical results of source samples document the presence of copper and uranium in source 1 (unlined holding basin), source 2 (unlined cooling water recharge pond), and source 3 (area of contaminated soil); calcium in source 1 (unlined holding basin); magnesium in source 1 (unlined holding basin) as a process element, and in source 3 (area of contaminated soil) [50, Tab. 3.3, p. 18; 54, p. 12; 61, pp. 1, 7, 11; 63, pp. 2-4, 8, 10].

The property is located in a mixed residential area. To the north is Main Street with commercial and residential properties, and the Assabet River. To the east are woodland and residential properties. To the west are woodland and commercial/industrial properties. To the south are woodland and residential properties [40, p. 3, Fig. 2]. No alternative anthropogenic sources of calcium, copper, magnesium, or uranium contamination in the sphagnum bog have been identified [3].

Hazardous Substances Released:

Based on chemical analysis of soil and/or sediment samples from source 1 (holding basin), source 2 (cooling water recharge pond), source 3 (area of contaminated soil), and based on documented past operational processes, the following substances meet the criteria for an observed release to surface water based on direct observation and chemical analysis criteria: calcium, copper, magnesium, and uranium.

Chemical Analysis

- Background Concentration (surficial sediments) - "collected from immediately below the layer of growing plants" [65, p. 4].

Sediment sample CB-14A was collected in the sphagnum bog, an isolated wetland, in May 1996 [65, p. 4, Tab. 1]. There is no upstream reference sample for the sphagnum bog [3; 8; 40, Fig. 2].

The reference sediment sample was analyzed for VOCs by EPA Method 8240, metals by EPA Method 6010, and uranium by ASTM Method D5174 [11; 58, pp. 9-10, 21].

The probable point of entry into the sphagnum bog is located at the two former discharge pipes. Therefore, in relation to the former discharge pipes, sediment sample CB-14A was collected on the west-central side of the sphagnum bog, approximately 120 feet northeast from discharge pipe No. 2 [40, Fig. 2; 65, Fig. 3].

Sediment sample CB-14A was collected in the sphagnum bog, outside from any lag zone. The laboratory analyzed sediment sample CB-14A for four VOCs, one metal, and uranium. Therefore, CB-14A was selected as a reference location for surficial sediments (collected immediately below the layer of growing plants) [40, Fig. 2; 58, pp. 9-10; 65, p. 4, Fig. 3]. Refer to Figure 6 for sediment sample locations.

Sample ID	Sampling Location	Depth	Date	Reference
CB-14A	sphagnum bog	surficial sediments	May 31, 1996	[58, pp. 9-10]

Available information provided the sampling depth as "surficial sediments (collected immediately below the layer of growing plants)" [65, p. 4, Tab. 1].

Sediment sample CB-14A, collected approximately 120 feet northeast from discharge pipe No. 2, was selected to establish background concentrations for sediment sample locations CP-2A, CB-11A, CB-12A, and CB-13A [58, pp. 9-10; 65, Fig. 3].

Hazardous Sample ID	Substance	Concentration	Sample Quantitation Limit	Reference
------------------------	-----------	---------------	---------------------------------	-----------

CB-14A	toluene	ND		50	ppb	[58, p. 9]
CB-14A	copper	33	ppm	0.012	ppm	[58, p. 10; 83]
CB-14A	uranium	1.54±0.21	†	0.112	◇	[58, p. 21]

ND = not detected. The chemical was analyzed for and was not detected.

◇ = MDA = minimum detectable activity

† = picoCuries per gram

ppm = parts per million

ppb = parts per billion

- Contaminated Samples (surficial sediments) - "collected from immediately below the layer of growing plants" [65, p. 4].

Sediment sample CP-2A and sediment samples CB-11A, CB-12A, CB-13A, and CB-14A were collected in the sphagnum bog in May 1996 [65, pp. 4-5, 13 Fig. 3].

Sediment sample CP-2A was collected at former discharge pipe No. 2 in the sphagnum bog. Sediment samples CB-11A, CB-12A, and CB-13A were collected from southeast to northwest across the central portion of the sphagnum bog [65, p. 4, Fig. 3, Tab. 1]. The samples were collected at depths and of materials similar to the depths and materials of the background sample CB-14A [65, pp. 4-5, 13, Tab. 1].

Sediment samples were analyzed for VOCs by EPA Method 8240, metals by EPA Method 6010, and uranium by ASTM Method D5174 [11; 58, pp. 2, 3, 5, 7, 21; 65, p. 4]. Refer to Figure 6 for sediment sample locations.

Sample ID	Sampling Location	Depth	Date	Reference
CP-2A	sphagnum bog	surface	May 31, 1996	[58, pp. 1-2, 19, 21; @]
CP-2A	sphagnum bog	surface	May 31, 1996	[58, pp. 1-2, 19, 21; @]
CB-11A	sphagnum bog	surface	May 31, 1996	[58, pp. 3-4, 19, 21; @]
CB-12A	sphagnum bog	surface	May 31, 1996	[58, pp. 5-6, 21; @]
CB-13A	sphagnum bog	surface	May 31, 1996	[58, pp. 7-8, 19, 21; @]

@ = Additional reference [65, pp. 4-5, 13, Fig. 3, Tab. 1]

Laboratory analyses detected the following chemicals at concentrations greater than or equal to three times the reference sample concentration (CB-14A) or greater than or equal to the sample quantitation limit: toluene, copper, and uranium [58, pp. 2, 3, 5, 7, 21].

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CB-11A	toluene	71 ppb	50 ppb	[58, p. 3; 83]
CB-12A	toluene	63 ppb	50 ppb	[58, p. 5; 83]
CB-13A	toluene	240 ppb	50 ppb	[58, p. 7; 83]
CP-2A	copper	227 ppm	0.012 ppm	[58, p. 2; 83]
CP-2A	uranium	29.1±3.91 †	0.112 ◇	[58, p. 21]

◇ = MDA = minimum detectable activity
† = picoCuries per gram
ppm = parts per million
ppb = parts per billion

Attribution:

From 1958 to 1985, NMI discharged process waste to the holding basin [42, p. 2; 43, p. 1-6]. They discharged the supernatant from the waste to the sphagnum bog; however, this practice was discontinued after a "brief use" [51, p. 19].

Analytical results of source samples document the presence of copper and uranium in source 1 (unlined holding basin), source 2 (unlined cooling water recharge pond), and source 3 (area of contaminated soil). None of the samples collected from the holding basin or cooling water recharge pond were analyzed for toluene; however, toluene was detected in liquid samples collected from the septic tanks (ST1 and ST2) on the property. Although identified in samples collected at the site, toluene is not associated with a specific source. GZA analyzed the samples from ST1 and ST2 for VOCs, semivolatile organic compounds, and metals. In addition to toluene, laboratory data indicated the presence of acetone; 2-butanone; carbon disulfide; chlorobenzene; 1,1-dichloroethane; ethylbenzene; methylene chloride; titanium; 1,1,1-trichloroethane; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; m-, o-, and p-xylene; and copper in the samples collected from ST1 and ST2 [69-76; 88, p. 11].

The property is located in a mixed residential area. To the north is Main Street with commercial and residential properties, and the Assabet River. To the east are woodland and residential properties. To the west are woodland and commercial/industrial properties. To the south are woodland and residential properties [40, p. 3, Fig. 2]. No alternative anthropogenic sources of toluene, copper, or uranium contamination in the sphagnum bog have been identified [3].

Hazardous Substances Released:

Based on chemical analysis of soil and/or sediment samples from source 1 (holding basin), source 2 (cooling water recharge pond), source 3 (area of contaminated soil), and based on documented past operational processes, the following substances meet the criteria for an observed release to the surface water migration pathway based on chemical analysis criteria: toluene, copper, and uranium.

Chemical Analysis

- Background Concentration (sediments) - collected at "5 feet below the surface of the bog" [65, p. 4].

Sediment sample CB-14B was collected in the sphagnum bog, an isolated wetland, in May 1996 [65, p. 4, Tab. 1]. There is no upstream reference sample for the sphagnum bog [3; 8; 40, Fig. 2].

The reference sediment sample was analyzed for VOCs by EPA Method 8240, metals by EPA Method 6010, uranium by ASTM Method D5174, and thorium isotopes by HASL 300 Method for Radiochemical Analysis [11; 58, pp. 9-10, 21].

The probable point of entry into the sphagnum bog is located at the two former discharge pipes. Therefore, in relation to the former discharge pipes, sediment sample CB-14B was collected on the west-central side of the sphagnum bog, approximately 120 feet northeast from discharge pipe No. 2 [40, Fig. 2; 65, Fig. 3].

Sediment sample CB-14B was collected in the sphagnum bog, outside from any lag zone. The laboratory analyzed sediment sample CB-14B for four VOCs, seven metals, uranium, and ²²⁸thorium, ²³⁰thorium, ²³²thorium. Therefore, CB-14B was selected as a reference location for sediments collected "5 feet below the surface of the bog" [40, Fig. 2; 58, pp. 17-18, 20, 21; 65, p. 4, Fig. 3]. Refer to Figure 6 for sediment sample locations.

Sample ID	Sampling Location	Depth	Date	Reference
CB-14B	sphagnum bog	†	May 31, 1996	[58, pp. 17-18, 20, 21; @]

@ = Additional reference [65, pp. 4-5, 13, Fig. 3, Tab. 1]

† = collected at "5 feet below the surface of the bog"

Sediment sample CB-14B, collected approximately 120 feet northeast from discharge pipe No. 2, was selected to establish background concentrations for sample locations CP-1B and CP-2B [58, pp. 18, 20, 21; 65, Fig. 3].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CB-14B	manganese	14.6	ppm	[58, p. 18; 83]
CB-14B	copper	ND	12.5 ppm	[58, p. 18]
CB-14B	²²⁸ thorium	0.006 ± 0.017	†	[58, p. 20]
CB-14B	²³⁰ thorium	ND	0.084	[58, p. 20]
CB-14B	²³² thorium	0.008 ± 0.013	†	[58, p. 20]
CB-14B	uranium	0.203 ± 0.029	†	[58, p. 21]

ND = not detected. The chemical was analyzed for and was not detected.

ppm = parts per million

† = picoCuries per gram

◇ = MDA = minimum detectable activity

- Contaminated Samples (sediment) - collected at "5 feet below the surface of the bog" [65, p. 4].

Sediment samples CP-1B and CP-2B were collected in the sphagnum bog, an isolated wetland, in May 1996 [65, pp. 4-5, Fig. 3, Tab. 1].

Sediment sample CP-1B and CP-2B were collected at former discharge pipe No. 1 and No. 2, respectively, in sphagnum bog. Sediment samples CB-11A, CB-12A, and CB-13A were collected from southeast to northwest across the central portion of the sphagnum bog [65, p. 4, Fig. 3, Tab. 1]. The samples were collected at depths and of materials similar to the depths and materials of the background sample CB-14B [65, pp. 4-5, 13, Tab. 1].

Sediment samples were analyzed for VOCs by EPA Method 8240, metals by EPA Method 6010, uranium by ASTM Method D5174, and thorium isotopes by HASL 300 Method for Radiochemical Analysis [11; 58, pp. 12, 14, 19, 21; 65, p. 4]. Refer to Figure 6 for sediment sample locations.

Sample ID	Sampling Location	Depth	Date	Reference
CP-1B	sphagnum bog	†	May 31, 1996	[58, pp. 11-12; @]
CP-2B	sphagnum bog	†	May 31, 1996	[58, pp. 13-14; @]

@ Additional reference [65, pp. 4-5, 13, Tab. 1, Fig. 3]

† = collected at "5 feet below the surface of the bog"

Laboratory analyses detected the following chemicals at concentrations greater than or equal to three times the reference sample concentration (CB-14B) or greater than or equal to the sample quantitation limit: copper, manganese, ²²⁸thorium, ²³⁰thorium, ²³²thorium, and uranium [58, pp. 12, 14, 19, 21].

The GZA analytical data used in this package were not validated. The data were submitted to the State of Massachusetts in response to Massachusetts Contingency Plan data reporting requirements. Additionally, select data were submitted to the Town of Concord, Massachusetts as part of a building permit for Building E. GZA indicated that they have a certified laboratory and stand behind the quality of their data [80].

Sample ID	Hazardous Substance	Concentration	Sample Quantitation Limit	Reference
CP-1B	manganese	66.9 ppm	0.002 ppm	[58, p. 12; 83]
CP-2B	copper	183 ppm	0.012 ppm	[58, p. 14; 83]
CP-2B	manganese	131 ppm	0.002 ppm	[58, p. 14; 83]
CP-1B	²²⁸ thorium	0.638±0.079 †	0.05 ◇	[58, p. 19]
CP-1B	²³⁰ thorium	0.653±0.076 †	0.018 ◇	[58, p. 19]
CP-1B	²³² thorium	0.598±0.072 †	0.018 ◇	[58, p. 19]
CP-1B	uranium	2.52±0.34 †	0.112 ◇	[58, p. 21]
CP-2B	²²⁸ thorium	0.905±0.091 †	0.036 ◇	[58, p. 19]
CP-2B	²³⁰ thorium	0.618±0.073 †	0.018 ◇	[58, p. 19]
CP-2B	²³² thorium	0.976±0.092 †	0.014 ◇	[58, p. 19]
CP-2B	uranium	20.6±2.78 †	0.112 ◇	[58, p. 21]

ppm = parts per million

† = picoCuries per gram

◇ = MDA = minimum detectable activity

Attribution:

From 1958 to 1985, NMI discharged process waste to the holding basin [42, p. 2; 43, p. 1-6]. They discharged the supernatant from the waste to the sphagnum bog; however, this practice was discontinued after a "brief use" [51, p. 19].

Analytical results of source samples document the presence of copper and uranium in source 1 (unlined holding basin), source 2 (unlined cooling water recharge pond), and source 3 (area of contaminated soil). Manganese has been detected in ground water from the supply wells associated with source 2 (unlined cooling water recharge pond). ²³⁰Thorium has been detected in source 1 (unlined holding basin) and ²²⁸thorium and ²³²thorium are known to be ²³²uranium and ²³⁶uranium radioactive decay products. Uranium has been documented on site. The thorium isotopes have been included as hazardous substances [50, Tab. 3.3, p. 18; 54, p. 12; 61, pp. 1, 7, 11; 63, pp. 2-4, 8, 10; 85-87].

The property is located in a mixed residential area. To the north is Main Street with commercial and residential properties, and the Assabet River. To the east are woodland and residential properties. To the west are woodland and commercial/industrial properties. To the south are woodland and residential properties [40, p. 3, Fig. 2]. No alternative anthropogenic sources of copper, manganese, ²²⁸thorium, ²³⁰thorium, ²³²thorium, and uranium contamination in the sphagnum bog have been identified [3].

Hazardous Substances Released:

Based on direct observation (documentation supporting discharge of hazardous substances into the bog); chemical analysis of soil and/or sediment samples from source 1 (holding basin), source 2 (cooling water recharge pond), and source 3 (area of contaminated soil); and past operational processes, the following substances meet the criteria for an observed release to the surface water migration pathway: copper, manganese, ²²⁸thorium, ²³⁰thorium, ²³²thorium, and uranium.

=====

Observed Release Factor Value: 550

4.1.2.2 WASTE CHARACTERISTICS

4.1.2.2.1 Toxicity/Persistence

The toxicity and persistence factor values are assigned to the hazardous substances associated with the sources and releases at the site based on the values presented in the Superfund Chemical Data Matrix (SCDM) [2].

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Toxicity/Persistence Factor Value (Table 4-12)	Reference
acetone	1	10	0.4	4	[2, p. B-1]
anthracene	2	10	1	10	[2, p. B-2]
BAA	2,3	1,000	1	1,000	[2, p. B-2]
BAP	2,3	10,000	1	10,000	[2, p. B-3]
BBF	2,3	1,000	1	1,000	[2, p. B-3]
benzene	■	100	0.4	40	[2, p. B-2]
BGHIP	2,3	NL	1	<>	[2, p. B-3]
BKF	2,3	100	1	100	[2, p. B-3]
C. disulfide	■	10	0.4	4	[2, p. B-4]
chrysene	2,3	10	1	10	[2, p. B-5]
cis-1,2-DCE	■	100	0.4	40	[2, p. B-8]
1,1-DCA	■	10	0.4	4	[2, p. B-7]
1,1-DCE	■	100	0.4	40	[2, p. B-7]
fluoranthene	2,3	100	1	100	[2, p. B-10]
HCl	1	100	0.4	40	[2, p. B-12]
IP	2,3	1,000	1	1,000	[2, p. B-12]
naphthalene	2	100	0.4	40	[2, p. B-14]
nitric acid	1	10	0.4	4	[2, p. B-14]
PCE	2	100	0.4	40	[2, p. B-18]
phenanthrene	2,3	NL	1	<>	[2, p. B-16]
pyrene	2,3	100	1	100	[2, p. B-17]
sulfuric acid	1	1,000	0.4	400	[2, p. B-18]
1,1,1-TCA	1,2	1	0.4	0.4	[2, p. B-19]
TCE	2	10	0.4	4	[2, p. B-19]
toluene	■	10	0.4	4	[2, p. B-19]
vinyl chloride	■	10,000	0.0007	7	[2, p. B-20]
arsenic	1,3	10,000	1	10,000	[2, p. B-2]
beryllium	1,3	10,000	1	10,000	[2, p. B-3]
calcium	1	NL	1	<>	[2, p. B-4]
copper	1,2,3	NL	1	<>	[2, p. B-6]
iron	2	1	1	1	[2, p. B-12]
magnesium	1,3	NL	1	<>	[2, p. B-13]
manganese	2	10,000	1	10,000	[2, p. B-13]
molybdenum	3	100	1	100	[2, p. B-14]
thorium	1	NL	NL	<>	[2]
uranium	1,2,3	NL	NL	<>	[2]

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Toxicity/ Persistence Factor Value (Table 4-12)	Reference
²¹⁰ lead	1	10,000	1	10,000	[2, p. B-85]
²²⁶ radium	1	10,000	1	10,000	[2, p. B-85]
²²⁸ thorium	■	10,000	1	10,000	[2, p. B-86]
²³⁰ thorium	1	10,000	1	10,000	[2, p. B-86]
²³² thorium	■	10,000	1	10,000	[2, p. B-87]
²³⁵ uranium	1,3	10,000	1	10,000	[2, p. B-87]
²³⁸ uranium	3	10,000	1	10,000	[2, p. B-87]

NL = factor value is not listed in SCDM

<> = not calculated because factor value is not listed in SCDM.

TCA = trichloroethane

TCE = trichloroethene

PCE = tetrachloroethene

DCA = dichloroethane

DCE = dichloroethene

HCl = hydrochloric acid

BAA = benzo(a)anthracene

BAP = benzo(a)pyrene

BBF = benzo(b)fluoranthene

BGHIP = benzo(ghi)perylene

BKF = benzo(k)fluoranthene

IP = indeno(123-cd)pyrene

C. disulfide = carbon disulfide

1 = source 1 = holding basin

2 = source 2 = cooling water recharge pond

3 = source 3 = contaminated soil

■ = Either these substances were not analyzed in a source sample or are known to be at the site but can not be associated with a specific source. Toluene was identified in liquid collected from an on-site septic system [69-76; 88, p. 11]. ²²⁸Thorium and ²³²thorium are known to be ²³²uranium and ²³⁶uranium radioactive decay products. Uranium has been documented on site. The thorium isotopes have been included as hazardous substances [85-87].

Persistence, bioaccumulation, and ecotoxicity values for fresh water rivers are used for the Surface Water Migration Pathway.

The highest toxicity/persistence value is 10,000 for benzo(a)pyrene, arsenic, beryllium, manganese, ²¹⁰lead, ²²⁶radium, ²²⁸thorium, ²³⁰thorium, ²³²thorium, ²³⁵uranium, and ²³⁸uranium.

From HRS Table 4-12, the toxicity factor value of 10,000 and persistence factor value of 1 are assigned a toxicity/persistence factor value of 10,000.

=====

Toxicity/Persistence Factor Value: 10,000

4.1.2.2.2 Hazardous Waste Quantity

A hazardous waste quantity is assigned to each source which has a containment factor value greater than zero for the surface water pathway [1, p. 51590].

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5.)	Is source hazardous constituent quantity data complete? (yes/no)
1	1,018.46	no
2	2,403.85	no
3	11.62	no
Sum of values: 3,434		

A surface water pathway hazardous waste quantity value greater than 100 to 10,000 is assigned a hazardous waste quantity factor value of 100 [1, pp. 51591, Table 2-6].

4.1.2.2.3 Waste Characteristics Factor Category Value

The toxicity/persistence factor value for ²³⁰thorium or manganese (10,000) is multiplied by the hazardous waste quantity factor value for the site (100) in order to determine the waste characteristics factor category value, subject to a maximum value of 1E+08 [1, pp. 51591, Table 2-7].

$$10,000 \times 100 = 1\text{E}+06$$

1E+06 is assigned a waste characteristics factor category value of 32 [1, p. 51592, Table 2-7].

Toxicity/persistence factor value
X hazardous waste quantity factor value: 1E+06

=====

Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 32

4.1.2.3 DRINKING WATER TARGETS

Level I Concentrations

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

Most Distant Level I Sample

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

Most Distant Level II Sample

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

4.1.2.3.1 Nearest Intake

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

=====

Nearest Intake Factor Value: 0

4.1.2.3.2 **Population**

4.1.2.3.2.2 Level I Concentration

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

=====

Population Served	
by Level I Intakes:	Level I Population Factor Value: 0

4.1.2.3.2.3 Level II Concentration

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

=====

Level II Population Factor Value: 0

4.1.2.3.2.4 Potential Contamination

The sphagnum bog is an isolated wetland. No drinking water intakes occur within the sphagnum bog [3; 22].

=====

Dilution-Weighted Population	
Served by Potentially	
Contaminated	
Intakes:	Potential Contamination Factor Value: 0

4.1.2.3.3 **Resources**

None identified.

=====

Resources Factor Value: 0

4.1.3.2 WASTE CHARACTERISTICS

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

The toxicity factor value, the persistence factor value, and the bioaccumulation factor value are assigned to the hazardous substances associated with the sources and releases at the site based on the values presented in SCDM [2].

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Bioaccumulation Value	Toxicity/Persistence/Bioaccumulation Factor Value (Table 4-16)	Ref.
acetone	1	10	0.4	0.5	2	[2, p. B-1]
anthracene	2	10	1	5,000	50,000	[2, p. B-2]
BAA	2,3	1,000	1	50,000	5E+07	[2, p. B-2]
BAP	2,3	10,000	1	50,000	5E+08	[2, p. B-3]
BBF	2,3	1,000	1	50,000	5E+07	[2, p. B-3]
benzene	■	100	0.4	5,000	2E+05	[2, p. B-2]
BGHIP	2,3	NL	1	50,000	<>	[2, p. B-3]
BKF	2,3	100	1	50,000	5E+06	[2, p. B-3]
C. disulfide	■	10	0.4	500	2,000	[2, p. B-4]
chrysene	2,3	10	1	500	5,000	[2, p. B-5]
cis-1,2-DCE	■	100	0.4	5	200	[2, p. B-8]
1,1-DCA	■	10	0.4	5	20	[2, p. B-7]
1,1-DCE	■	100	0.4	50	2,000	[2, p. B-7]
fluoranthene	2,3	100	1	5,000	5E+05	[2, p. B-10]
HCl	1	100	0.4	0.5	20	[2, p. B-12]
IP	2,3	1,000	1	50,000	5E+07	[2, p. B-12]
naphthalene	2	100	0.4	500	20,000	[2, p. B-14]
nitric acid	1	10	0.4	0.5	2	[2, p. B-14]
PCE	2	100	0.4	50	2,000	[2, p. B-18]
phenanthrene	2,3	NL	1	50	<>	[2, p. B-16]
pyrene	2,3	100	1	50	5,000	[2, p. B-17]
sulfuric acid	1	1,000	0.4	0.5	200	[2, p. B-18]
1,1,1-TCA	1,2	1	0.4	5	2	[2, p. B-19]
TCE	2	10	0.4	50	200	[2, p. B-19]
toluene	■	10	0.4	50	200	[2, p. B-19]
vinyl chloride	■	10,000	0.0007	5	35	[2, p. B-20]
arsenic	1,3	10,000	1	5	50,000	[2, p. B-2]
beryllium	1,3	10,000	1	50	5E+05	[2, p. B-3]
calcium	1	NL	1	500	<>	[2, p. B-4]
copper	1,2,3	NL	1	50,000	<>	[2, p. B-6]
iron	2	1	1	0.5	0.5	[2, p. B-12]
magnesium	1,3	NL	1	0.5	<>	[2, p. B-13]
manganese	2	10,000	1	0.5	5,000	[2, p. B-13]
molybdenum	3	100	1	0.5	50	[2, p. B-14]
thorium	1	NL	NL	NL	<>	[2]
uranium	1,2,3	NL	NL	NL	<>	[2]

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value	Bioaccumulation Value	Toxicity/Persistence/Bioaccumulation Factor Value (Table 4-16)	Ref.
²¹⁰ lead	1	10,000	1	50	5E+05	[2, p. B-85]
²²⁶ radium	1	10,000	1	5,000	5E+07	[2, p. B-85]
²²⁸ thorium	■	10,000	1	500	5E+06	[2, p. B-86]
²³⁰ thorium	1	10,000	1	500	5E+06	[2, p. B-86]
²³² thorium	■	10,000	1	500	5E+06	[2, p. B-87]
²³⁵ uranium	1,3	10,000	1	500	5E+06	[2, p. B-87]
²³⁸ uranium	3	10,000	1	500	5E+06	[2, p. B-87]

NL = factor value is not listed in SCDM
 <> = not calculated because factor value is not listed in SCDM.
 TCA = trichloroethane
 TCE = trichloroethene
 PCE = tetrachloroethene
 DCA = dichloroethane
 DCE = dichloroethene
 HCl = hydrochloric acid
 BAA = benzo(a)anthracene
 BAP = benzo(a)pyrene
 BBF = benzo(b)fluoranthene
 BGHIP = benzo(ghi)perylene
 BKF = benzo(k)fluoranthene
 IP = indeno(123-cd)pyrene
 C. disulfide = carbon disulfide
 1 = source 1 = holding basin
 2 = source 2 = cooling water recharge pond
 3 = source 3 = contaminated soil
 ■ = Either these substances were not analyzed in a source sample or are known to be at the site but can not be associated with a specific source. Toluene was identified in liquid collected from an on-site septic system [69-76; 88, p. 11]. ²²⁸Thorium and ²³²thorium are known to be ²³²uranium and ²³⁶uranium radioactive decay products. Uranium has been documented on site. The thorium isotopes have been included as hazardous substances [85-87].

Persistence, bioaccumulation, and ecotoxicity values for fresh water rivers are used for the Surface Water Migration Pathway.

The highest toxicity/persistence value is 10,000 for benzo(a)pyrene, arsenic, beryllium, manganese, ²¹⁰lead, ²²⁶radium, ²²⁸thorium, ²³⁰thorium, ²³²thorium, ²³⁵uranium, and ²³⁸uranium.

From HRS Table 4-12, a toxicity factor value of 10,000 and a persistence factor value of 1 are assigned a toxicity/persistence factor value of 10,000 [1, p. 51613].

From HRS Table 4-16, a toxicity/persistence factor value of 10,000 and a bioaccumulation factor value of 50,000 are assigned a toxicity/persistence/bioaccumulation factor value of 5E+08 [1, p. 51619].

=====

Toxicity/Persistence/Bioaccumulation Factor Value: 5E+08

4.1.3.2.2 Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5.)	Is source hazardous constituent quantity data complete? (yes/no)
1	1,018.46	no
2	2,403.85	no
3	11.62	no
Sum of values: 3,434		

A surface water pathway hazardous waste quantity value greater than 100 to 10,000 is assigned a hazardous waste quantity factor value of 100 [1, pp. 51591, Table 2-6].

4.1.3.2.3 Waste Characteristics Factor Category Value

A toxicity/persistence factor value of 10,000 is multiplied by the hazardous waste quantity factor value for the site (100) in order to determine the waste characteristics factor category value, subject to a maximum value of 1E+08 [1, pp. 51591, Table 2-7].

$$10,000 \times 100 = 1E+06$$

$$\begin{array}{l} \text{Toxicity/persistence factor value} \\ \times \text{hazardous waste quantity factor value: } 1E+06 \end{array}$$

The product of the toxicity/persistence factor value and hazardous waste quantity factor value for the watershed, (subject to a maximum value of 1E+08) are multiplied by the bioaccumulation potential factor value (50,000), subject to a maximum of 1E+12 [1, p. 51620].

$$1E+06 \times 50,000 = 5E+10$$

$$\begin{array}{l} (\text{Toxicity/persistence} \times \text{hazardous waste quantity}) \\ \times \text{bioaccumulation potential factor value: } 5E+10 \end{array}$$

From HRS Table 2-7, toxicity/persistence x hazardous waste quantity x bioaccumulation potential factor value of 5E+10 is assigned a human food chain threat - waste characteristics factor category value of 320 [1, pp. 51592, 51620].

=====

Hazardous Waste Quantity Assigned Value: 100
Waste Characteristics Factor Category Value: 320

4.1.3.3 HUMAN FOOD CHAIN THREAT-TARGETS

No human food chain threat targets occur within the sphagnum bog. The sphagnum bog is not considered a fishery [1, pp. 51620-51621; 81].

Actual Human Food Chain Contamination**Surface Water and Sediment Samples**

Sample ID	Distance from Probable Point of Entry	Hazardous Substance	Bioaccumulation Potential Factor Value
-----------	--	---------------------	--

Not scored

Closed Fisheries

Identity of fishery	Hazardous Substance
---------------------	---------------------

Not scored

Sample ID	Distance from Probable Point of Entry	Hazardous Substance
-----------	--	---------------------

Not scored

Benthic Tissue

Sample ID	Distance from the probable point of entry	Organism
-----------	---	----------

Not scored

Most Distant Level I Sample

Sample ID:
Distance from the probable point of entry:
Reference:

Level I Fisheries

Identity of fishery	Extent of the Level I Fishery (Relative to Probable Point of Entry)
---------------------	--

Not scored

Most Distant Level II Sample

Sample ID:
Distance from the probable point of entry:
Reference:

Level II Fisheries

Identity of fishery	Extent of the Level II Fishery (Relative to Probable Point of Entry)
---------------------	---

Not scored

SWOF/Food Chain-Food Chain Individual

4.1.3.3.1 Food Chain Individual

No human food chain threat targets are documented within the sphagnum bog. The sphagnum bog is not considered a fishery [1, pp. 51620-51621; 81].

Sample ID:
Hazardous Substance:
Bioaccumulation Potential:

<u>Identity of Fishery</u>	<u>Type of Surface Water Body</u>	<u>Reference</u>	<u>Dilution Weight</u>
----------------------------	-----------------------------------	------------------	------------------------

Not scored

=====

Food Chain Individual Factor Value: 0

4.1.3.3.2 **Population**4.1.3.3.2.1 Potential Human Food Chain Contamination

No potential human food chain threat targets occur within the sphagnum bog [1, pp, 51620-51621; 81].

Identity of <u>Fishery</u>	Annual Production (pounds)	Type of Surface Water Body	Average Annual Flow	Ref.	Population Value (P_i)	Dilution Weight (D_i)	$P_i \times D_i$
----------------------------------	----------------------------------	-------------------------------------	---------------------------	------	-------------------------------	------------------------------	------------------

Not scored

Sum of $P_i \times D_i$:
(Sum of $P_i \times D_i$)/10:

=====

Potential Human Food Chain Contamination Factor Value: 0

4.1.3.3.2.2 Level I Concentrations

No human food chain threat targets occur within the sphagnum bog [1, pp. 51620-51621; 81].

<u>Identity of</u> <u>Fishery</u>	<u>Annual Production</u> <u>(pounds)</u>	<u>Reference</u>	<u>Human Food Chain</u> <u>Population Value</u>
--------------------------------------	---	------------------	--

Not scored

Sum of Human Food Chain Population Values:

=====

Level I Concentrations Factor Value: 0

4.1.3.3.2.3 Level II Concentrations

No human food chain threat targets occur within the sphagnum bog [1, pp. 51620-51621; 81].

<u>Identity of</u> <u>Fishery</u>	<u>Annual Production</u> <u>(pounds)</u>	<u>Reference</u>	<u>Human Food Chain</u> <u>Population Value</u>
--------------------------------------	---	------------------	--

Not scored

=====Level II Concentrations Factor Value: 0
SWOF/Environment-Toxicity/Persistence/Bioaccumulation

4.1.4.2 WASTE CHARACTERISTICS

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

The ecosystem toxicity factor value and the persistence factor value are assigned to the hazardous substances associated with the sources and releases at the site based on the values presented in SCDM [2].

Hazardous Substance	Source No.	Ecosystem Toxicity Factor Value	Persistence Factor Value	Ecosystem toxicity/Persistence Factor Value (Table 4-20)	Reference
acetone	1	100	0.4	40	[2, p. B-1]
anthracene	2	10,000	1	10,000	[2, p. B-2]
BAA	2,3	10,000	1	10,000	[2, p. B-2]
BAP	2,3	10,000	1	10,000	[2, p. B-3]
BBF	2,3	NL	1	<>	[2, p. B-3]
benzene	■	100	0.4	40	[2, p. B-2]
BGHIP	2,3	NL	1	<>	[2, p. B-3]
BKF	2,3	NL	1	<>	[2, p. B-3]
C. disulfide	■	100	0.4	40	[2, p. B-4]
chrysene	2,3	1,000	1	1,000	[2, p. B-5]
cis-1,2-DCE	■	NL	0.4	<>	[2, p. B-8]
1,1-DCA	■	NL	0.4	<>	[2, p. B-7]
1,1-DCE	■	10	0.4	4	[2, p. B-7]
fluoranthene	2,3	10,000	1	10,000	[2, p. B-10]
HCl	1	1	0.4	0.4	[2, p. B-12]
IP	2,3	NL	1	<>	[2, p. B-12]
naphthalene	2	1,000	0.4	400	[2, p. B-14]
nitric acid	1	NL	0.4	<>	[2, p. B-14]
PCE	2	100	0.4	40	[2, p. B-18]
phenanthrene	2,3	1,000	1	1,000	[2, p. B-16]
pyrene	2,3	10,000	1	10,000	[2, p. B-17]
sulfuric acid	1	10	0.4	4	[2, p. B-18]
1,1,1-TCA	1,2	10	0.4	4	[2, p. B-19]
TCE	2	100	0.4	40	[2, p. B-19]
toluene	■	100	0.4	40	[2, p. B-19]
vinyl chloride	■	NL	0.0007	<>	[2, p. B-20]
arsenic	1,3	10	1	10	[2, p. B-2]
beryllium	1,3	NL	1	<>	[2, p. B-3]
calcium	1	NL	1	<>	[2, p. B-4]
copper	1,2,3	100	1	100	[2, p. B-6]
iron	2	10	1	10	[2, p. B-12]
magnesium	1,3	NL	1	<>	[2, p. B-13]
manganese	2	NL	1	<>	[2, p. B-13]
molybdenum	3	NL	1	<>	[2, p. B-14]
thorium	1	NL	NL	<>	[2]
uranium	1,2,3	NL	NL	<>	[2]

Hazardous Substance	Source No.	Ecosystem Toxicity Factor Value	Persistence Factor Value	Ecosystem toxicity/ Persistence Factor Value (Table 4-20)	Reference
²¹⁰ lead	1	10,000	1	10,000	[2, p. B-85]
²²⁶ radium	1	10,000	1	10,000	[2, p. B-85]
²²⁸ thorium	■	10,000	1	10,000	[2, p. B-86]
²³⁰ thorium	1	10,000	1	10,000	[2, p. B-86]
²³² thorium	■	10,000	1	10,000	[2, p. B-87]
²³⁵ uranium	1,3	10,000	1	10,000	[2, p. B-87]
²³⁸ uranium	3	10,000	1	10,000	[2, p. B-87]

NL = factor value not listed in SCDM

<> = not calculated because factor value is not listed in SCDM.

TCA = trichloroethane

TCE = trichloroethene

PCE = tetrachloroethene

DCA = dichloroethane

DCE = dichloroethene

HCl = hydrochloric acid

BAA = benzo(a)anthracene

BAP = benzo(a)pyrene

BBF = benzo(b)fluoranthene

BGHIP = benzo(ghi)perylene

BKF = benzo(k)fluoranthene

IP = indeno(123-cd)pyrene

C. disulfide = carbon disulfide

1 = source 1 = holding basin

2 = source 2 = cooling water recharge pond

3 = source 3 = contaminated soil

■ = Either these substances were not analyzed in a source sample or are known to be at the site but can not be associated with a specific source. Toluene was identified in liquid collected from an on-site septic system [69-76; 88, p. 11]. ²²⁸Thorium and ²³²thorium are known to be ²³²uranium and ²³⁶uranium radioactive decay products. Uranium has been documented on site. The thorium isotopes have been included as hazardous substances [85-87].

Persistence, bioaccumulation, and ecotoxicity values for fresh water rivers are used for the Surface Water Migration Pathway.

From HRS Table 4-20, an ecosystem toxicity factor value of 10,000 and a persistence factor value of 1 (anthracene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, pyrene, ²¹⁰lead, ²²⁶radium, ²²⁸thorium, ²³⁰thorium, ²³²thorium, ²³⁵uranium, and ²³⁸uranium) are assigned an ecosystem toxicity/persistence factor value of 10,000 [1, p. 51622].

Hazardous Substance	Ecosystem Toxicity/ Persistence Factor Value	Ecosystem Bioaccumulation Factor Value (Section 4.1.3.2.1.2)	Ecosystem Toxicity/ Persistence/ Bioaccumulation Factor Value (Table 4-21)	Reference
acetone	40	0.5	20	[2, p. B-1]
anthracene	10,000	5,000	5E+07	[2, p. B-2]
BAA	10,000	50,000	5E+08	[2, p. B-2]
BAP	10,000	50,000	5E+08	[2, p. B-3]
BBF	<>	50,000	<>	[2, p. B-3]
benzene	40	500	20,000	[2, p. B-2]
BGHIP	<>	50,000	<>	[2, p. B-3]
BKF	<>	50,000	<>	[2, p. B-3]
C. disulfide	40	500	2,000	[2, p. B-4]
chrysene	1,000	5,000	5E+06	[2, p. B-5]
cis-1,2-DCE	<>	5	<>	[2, p. B-8]
1,1-DCA	<>	5	<>	[2, p. B-7]
1,1-DCE	4	50	200	[2, p. B-7]
fluoranthene	10,000	500	5E+06	[2, p. B-10]
HCl	0.4	0.5	0.2	[2, p. B-12]
IP	<>	50,000	<>	[2, p. B-12]
naphthalene	400	500	2E+05	[2, p. B-14]
nitric acid	<>	0.5	<>	[2, p. B-14]
PCE	40	50	2,000	[2, p. B-18]
phenanthrene	1,000	5,000	5E+06	[2, p. B-16]
pyrene	10,000	50	5E+05	[2, p. B-17]
sulfuric acid	4	0.5	2	[2, p. B-18]
1,1,1-TCA	4	5	20	[2, p. B-19]
TCE	40	50	2,000	[2, p. B-19]
toluene	40	50	2,000	[2, p. B-19]
vinyl chloride	<>	5	<>	[2, p. B-20]
arsenic	10	500	5,000	[2, p. B-2]
beryllium	<>	50	<>	[2, p. B-3]
calcium	<>	500	<>	[2, p. B-4]
copper	100	50,000	5E+06	[2, p. B-6]
iron	10	0.5	5	[2, p. B-12]
magnesium	<>	0.5	<>	[2, p. B-13]
manganese	<>	50,000	<>	[2, p. B-13]
molybdenum	<>	0.5	<>	[2, p. B-14]
thorium	<>	NL	<>	[2]
uranium	<>	NL	<>	[2]

Hazardous Substance	Ecosystem Toxicity/ Persistence Factor Value	Ecosystem Bioaccumulation Factor Value (Section 4.1.3.2.1.2)	Ecosystem Toxicity/ Persistence/ Bioaccumulation Factor Value (Table 4-21)	Reference
²¹⁰ lead	10,000	5,000	5E+07	[2, p. B-85]
²²⁶ radium	10,000	5,000	5E+07	[2, p. B-85]
²²⁸ thorium	10,000	500	5E+06	[2, p. B-86]
²³⁰ thorium	10,000	500	5E+06	[2, p. B-86]
²³² thorium	10,000	500	5E+06	[2, p. B-87]
²³⁵ uranium	10,000	500	5E+06	[2, p. B-87]
²³⁸ uranium	10,000	500	5E+06	[2, p. B-87]

NL = factor value is not listed in SCDM
 <> = not calculated because factor value is not listed in SCDM.
 TCA = trichloroethane
 TCE = trichloroethene
 PCE = tetrachloroethene
 DCA = dichloroethane
 DCE = dichloroethene
 HCl = hydrochloric acid
 BAA = benzo(a)anthracene
 BAP = benzo(a)pyrene
 BBF = benzo(b)fluoranthene
 BGHIP = benzo(ghi)perylene
 BKF = benzo(k)fluoranthene
 IP = indeno(123-cd)pyrene
 C. disulfide = carbon disulfide

From HRS Table 4-21, an ecosystem toxicity/persistence factor value of 10,000 and a bioaccumulation factor value of 50,000 (benzo(a)anthracene and benzo(a)pyrene) are assigned an ecosystem toxicity/persistence/ bioaccumulation factor value of 5E+08 [1, p. 51623].

=====

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 5E+08

4.1.4.2.2. Hazardous Waste Quantity

<u>Source Number</u>	<u>Source Hazardous Waste Quantity Value (Section 2.4.2.1.5.)</u>	<u>Is source hazardous constituent quantity data complete? (yes/no)</u>
1	1,018.46	no
2	2,403.85	no
3	11.62	no
	Sum of values: 3,434	

A surface water pathway hazardous waste quantity value greater than 100 to 10,000 is assigned a hazardous waste quantity factor value of 100 [1, pp. 51591, Table 2-6].

4.1.4.2.3. Waste Characteristics Factor Category Value

An ecosystem toxicity/persistence factor value of 10,000 is multiplied by the hazardous waste quantity factor value for the watershed (100) in order to determine the waste characteristics factor category value, subject to a maximum value of 1E+08 [1, pp. 51591, Table 2-7].

$$10,000 \times 100 = 1E+06$$

ecosystem toxicity/persistence factor value
X hazardous waste quantity factor value: 1E+06

The product of the ecosystem toxicity/persistence factor value and hazardous waste quantity factor value for the watershed (subject to a maximum value of 1E+08) are multiplied by the bioaccumulation potential factor value (50,000), subject to a maximum of 1E+12 [1, p. 51620].

$$1E+06 \times 50,000 = 5E+10$$

(ecosystem toxicity/persistence x hazardous waste quantity)
X bioaccumulation potential factor value: 5E+10

From HRS Table 2-7, a toxicity/persistence x hazardous waste quantity x bioaccumulation potential factor value of 5E+10 is assigned an environment threat - waste characteristics factor category value of 320 [1, pp. 51592, 51620].

=====

Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 320

4.1.4.3 ENVIRONMENTAL THREAT - TARGETS

The sphagnum bog covers approximately 4 acres [8]. The sphagnum bog is a palustrine, broad-leaved evergreen, scrub-shrub, saturated, acidic wetland located approximately 75 feet east of both the cooling water recharge pond and the holding basin [3; 8; 40, Fig. 2]. The sphagnum bog is a "state- designated area for the protection and maintenance of aquatic life, designated under section 305(a) of the Clean Water Act" [39].

During NMI's operations, the supernatant from the holding basin was discharged to the sphagnum bog through two pipes located along the southwest portion of the sphagnum bog. This practice was discontinued after a "brief use" [51, p. 19].

The sphagnum bog is an isolated wetland [8]. Surface water samples CBSW-6, CBSW-7, CBSW-8, CBSW-10, CB-16AD, CB-17AD, CB-18AD, CB-19AD, and CB-20AD were collected from the sphagnum bog [65, Fig. 3]. Refer to Figure 6 for surface water sample locations.

Level I Concentrations

Sample ID: CBSW-6
 Sample Medium: Surface Water
 Location: sphagnum bog
 (25 feet northeast of former discharge pipe No. 1)
 Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	75 ppb	12 ppb	AWQC/AALAC

Level I Concentrations

Sample ID: CBSW-7
 Sample Medium: Surface Water
 Location: sphagnum bog
 (140 feet east of former discharge pipe No. 1)
 Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	122 ppb	12 ppb	AWQC/AALAC

Level I Concentrations

Sample ID: CBSW-8
Sample Medium: Surface Water
Location: sphagnum bog
(25 feet north of former discharge pipe No. 2)
Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	92 ppb	12 ppb	AWQC/AALAC

Level I Concentrations

Sample ID: CBSW-10
Sample Medium: Surface Water
Location: sphagnum bog
(395 feet northeast of former discharge pipe No. 2)
Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	27 ppb	12 ppb	AWQC/AALAC

Level I Concentrations

Sample ID: CB-16AD
Sample Medium: Surface Water
Location: sphagnum bog
(70 feet northeast of former discharge pipe No. 2)
Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	70 ppb	12 ppb	AWQC/AALAC

Level I Concentrations

Sample ID: CB-17AD
Sample Medium: Surface Water
Location: sphagnum bog
(140 feet east of former discharge pipe No. 1)
Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	117 ppb	12 ppb	AWQC/AALAC

Level I Concentrations

Sample ID: CB-18AD

Sample Medium: Surface Water
Location: sphagnum bog
(70 feet northeast of former discharge pipe No. 1)
Reference: 65, Fig. 3

<u>Hazardous Substance</u>	<u>Hazardous Substance Concentration</u>	<u>Benchmark Concentration</u>	<u>Benchmark</u>
Copper	140 ppb	12 ppb	AWQC/AALAC

ppb = parts per billion

Reference for Benchmarks: [2, p. B-48]

Most Distant Level I Sample

Sample ID: CBSW-10
Distance from the probable point of entry: ~395 feet
Reference: [65, Fig. 3]

Most Distant Level II Sample

Sample ID: CB-11A
Distance from the probable point of entry: ~280 feet
Reference: [65, Fig. 3]

4.1.4.3.1 Sensitive Environments**4.1.4.3.1.1. Level I Concentrations**

The observed release to surface water (sphagnum bog) from the site is established by surface water sample analytical results [57, pp. 1-18]. Sensitive environments determined to be actual contamination targets based on surface water sample analytical results are evaluated as subject to actual contamination at Level I [1, p. 51625]. The sphagnum bog is a surface water body that meets the requirements for environmental threat target under "a state-designated area for the protection and maintenance of aquatic life, designated under section 305(a) of the Clean Water Act" [1, p. 51624; 39]. State-designated areas for the protection and maintenance of aquatic life are assigned a sensitive environment value of 5 [1, p. 51624, Tab. 4-23].

Sensitive Environments

<u>Sensitive Environment</u>	<u>Distance from Probable Point of Entry to Nearest Point of Sensitive Environment</u>	<u>Reference</u>	<u>Sensitive Environment Value(s)</u>
State-designated areas for the protection and maintenance of aquatic life under the Clean Water Act	0 feet	[39; 65, Fig. 3]	5

Sum of Sensitive Environment Values: 5

Wetlands

The observed release to surface water from the site is established by chemical analysis [57, pp. 1-18]. Sensitive environments that are determined to be actual contamination targets based on surface water sample analytical results are evaluated as subject to actual contamination at Level I [1, p. 51625]. Approximately 0.31 of a mile of wetland frontage exists along the sphagnum bog from the probable point of entry to the most distant sample location that documents Level I contamination [78]. Between 0.1 and 1 mile of wetland frontage is assigned a wetland rating value of 25 [1, p. 51625, Tab. 4-24].

<u>Wetland</u>	<u>Wetland Frontage</u>	<u>Reference</u>
sphagnum bog	0.31 of a mile	[65, Fig. 3; 78]

Total Wetland Frontage: 0.31 of a mile

Wetland Value: 25

Sum of Sensitive Environment Values + Wetland Value: 30

The Sum of Sensitive Environment Values and Wetland Value are multiplied by 10 to determine the Level I Concentrations Factor Value [1, p. 51614].

=====

Level I Concentrations Factor Value: 300

4.1.4.3.1.2. Level II Concentrations

The observed release to surface water from the site is established by surface water sample analytical results [57, pp. 1-18]. Sensitive environments determined to be actual contamination targets based on surface water sample analytical results are evaluated as subject to actual contamination at Level I [1, p. 51625]. The area defined by actual contamination at Level I is greater than and overlaps the area defined by actual contamination at Level II; therefore actual contamination at Level II has not been scored [78].

Sensitive Environments

	Distance from Probable Point of Entry to Nearest Point of Sensitive Environment	Reference	Sensitive Environment Value(s)
<u>Sensitive Environment</u>	<u>Environment</u>	<u>Reference</u>	<u>Value(s)</u>

Not scored

Sum of Sensitive Environment Values: not scored

Wetlands

<u>Wetland</u>	<u>Wetland Frontage</u>	<u>Reference</u>
----------------	-------------------------	------------------

Not scored

Total Wetland Frontage:

Wetland Value: not scored

Sum of Sensitive Environment Values + Wetland Value: not scored

=====

Level II Concentrations Factor Value: not scored

4.1.4.3.1.3 Potential Contamination

For a closed lake (that is, a lake without surface water flow entering or leaving), assign a dilution weight based on the average annual groundwater flow into the lake, if available, using the dilution weight for the corresponding river flow rate in Table 4-13. If this is not available, assign a default dilution weight of 1 [1, p. 51614].

The flow rate of the sphagnum bog is estimated to be 0.27 cubic feet per second, based on USGS mean annual run off data for New England (22 inches per year), converted to 1.62 cubic feet per second per square mile of drainage basin area, and the drainage area of the bog [33]. A water body with a flow rate of 0.27 cubic feet per second is identified as a minimal stream [1, p. 51613, Table 4-13]. From HRS Table 4-13, a minimal stream (less than 10 cubic feet per second) is assigned a dilution weight of 1 [1, p. 51613].

Sensitive Environments

No sensitive environments were identified within the sphagnum bog between the most distant surface water sample that documents Level I contamination and the target distance limit [12].

Type of Surface Water Body	Sensitive Environment	Reference	Sensitive Environment Value(s)
Minimal stream	none identified	[12]	0

Approximately 0.05 of a mile of wetlands were identified along the sphagnum bog between the most distant surface water sample which documents Level I contamination and the target distance limit [8; 40, Fig. 2]. Less than 0.1 of a mile of wetland frontage is assigned a wetland rating value of 0 [1, p. 51625, Tab. 4-24].

Wetlands

Type of Surface Water Body	Wetlands Frontage	Reference	Wetlands Value for Type of Surface Water Body
minimal stream	0.05 mile	[8; 65, Fig. 3; 78]	0

Type of Surface Water Body	Sum of Sensitive Environment Values (S_j)	Wetland Frontage Value (W_j)	Dilution Weight (D_j)	$D_j(W_j + S_j)$
minimal stream	0	0	1	0

$$\text{Sum of } D_j(W_j + S_j): 0$$

$$(\text{Sum of } D_j(W_j + S_j))/10: 0$$

=====

Potential Contamination Factor Value: 0

4.2 GROUND WATER TO SURFACE WATER MIGRATION COMPONENT

**4.2.1.1 DEFINITION OF HAZARDOUS SUBSTANCE MIGRATION PATH FOR GROUND
WATER TO SURFACE WATER COMPONENT**

Not scored

APPENDIX A

**FIGURES
(1-6)**

A copy of Figure 1 is available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov

A copy of Figure 2 is available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov

A copy of Figure 3 is available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov

A copy of Figure 4 is available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov

A copy of Figure 5 is available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov

A copy of Figure 6 is available at the EPA Headquarters Superfund Docket:

U.S. CERCLA Docket Office
Crystal Gateway #1, 1st Floor
1235 Jefferson Davis Highway
Arlington, VA 22202

Telephone: (703) 603-8917
E-Mail: superfund.docket@epa.gov